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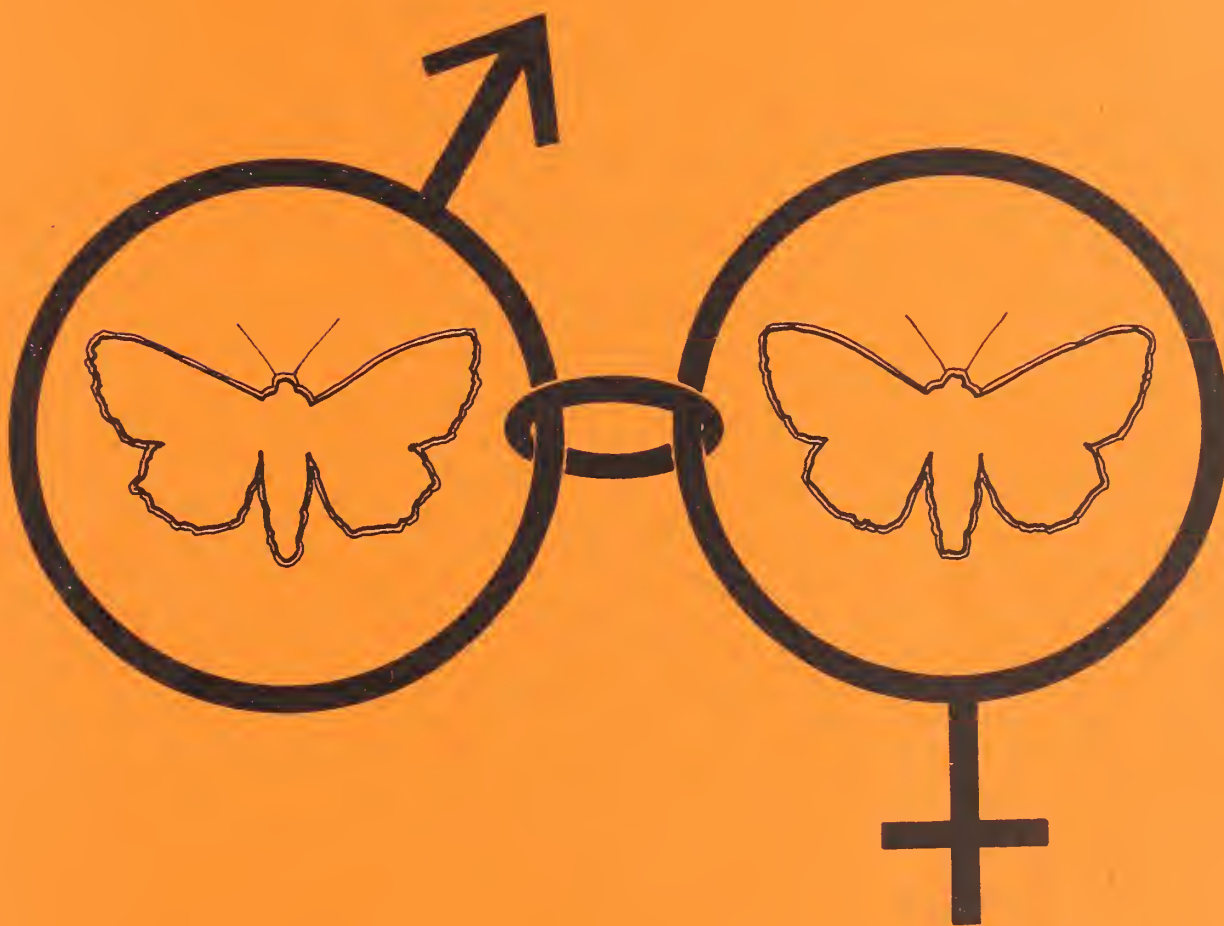
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INSECT ATTRACTANTS, BEHAVIOR, AND BASIC BIOLOGY
RESEARCH LABORATORY

Gainesville, Florida

FIRST SEMI-ANNUAL REPORT - 1978

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FIRST SEMI-ANNUAL REPORT

1978

Insect Attractants, Behavior, and Basic Biology

Research Laboratory

USDA-SEA, Southern Region, Florida-Antilles Area

P.O. Box 14565

Gainesville, Florida 32604

In cooperation with the Departments of

Entomology and Nematology

and

Agricultural Engineering

University of Florida

This progress report includes tentative results of research not sufficiently complete to justify general release. Such findings when adequately confirmed will be released through established channels. Therefore, this report is not intended for publication and should not be referred to in literature citations.

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Effect of Juvenile Hormone and Its Mimics on Mitochondrial
Metabolism in the Indian Meal Moth,
Plodia interpunctella: Mechanisms of Action

D. L. Silhacek and M. Landau

(Continuation of report 01 77(7-12))

Objective: To determine the biochemical mechanisms of juvenile hormone (JH) action. The present work focuses on the effects of JH on mitochondrial metabolism.

Methods: Indian meal moths were reared on normal diet at 130°, 20°, and 30°C. Mitochondria were isolated at various intervals after the last larval-larval molt. Mitochondrial oxidation values were determined with a vibrating platinum electrode.

Results: Previously reported studies suggested that low temperature (23°C) rearing altered the metabolism of isolated larval mitochondria. Similar alterations but of a greater magnitude could be achieved by adding JH to the isolated mitochondria. Rearing larvae at even lower temperatures (18°, 20°) did not intensify the effects to the same magnitude provided by JH; in fact, JH addition to 18° mitochondria intensified the mitochondrial effects.

Plans: Studies on JH effects on the synthesis of cytochromes will be resumed.

Hormonal Control of Chitin Synthesis In Vitro

H. Oberlander, S. M. Ferkovich, F. Van Essen and C. E. Leach

(Continuation of report 02 77(7-12))

Objective: To determine the mode of action of insect hormones on the biosynthesis of chitin.

Methods: We have investigated the stimulation of cuticle production by Plodia interpunctella imaginal disks in tissue culture. We used biochemical methods to assess the quantitative effects of beta-ecdysone on chitin biosynthesis in wing disks incubated in vitro with 0.5 μCi of C^{14} -glucosamine for the final 24 hr of culture. We demonstrated that the isotope was incorporated into chitin by trapping the radiolabeled material on glass filters and incubated with and without chitinase (10 mg/ml 0.05 M acetate, pH 5.2) at 37°C for 48 hr. Subsequent filtration and counting of the incubated samples revealed a 95% reduction in radioactivity trapped on the chitinase-treated sample relative to the untreated chitin sample.

Results: The first objective of these experiments was to establish a time-course for chitin biosynthesis following treatment with β -ecdysone. There was a marked stimulation (about 700% vs. control) in chitin synthesis during the second day following addition of hormone. The elevated incorporation levels are maintained for a five-day period before dropping to control levels. We next demonstrated that imaginal disks respond to increasing concentrations of β -ecdysone with increased synthesis. Threshold is between 0.01 and 0.1 $\mu\text{g}/\text{ml}$ of hormone ($2 \times 10^{-8}\text{M}$ to $2 \times 10^{-7}\text{M}$). The isotope incorporation rate levels off between 10.0 and 50 $\mu\text{g}/\text{ml}$. From 0.1 to 10.0 $\mu\text{g}/\text{ml}$ the level of incorporation is proportional to the log of the β -ecdysone concentration. These data represent the first quantitative demonstration of the biosynthesis of chitin by developing tissue in vitro in relation to varying amounts of hormone.

Simultaneous exposure of cultured wing disks to β -ecdysone and cycloheximide, an inhibitor of protein synthesis, blocked the subsequent appearance of cuticle. We measured C^{14} -glucosamine incorporation into chitin 2 days after incubation of the disks with β -ecdysone (0.5 $\mu\text{g}/\text{ml}$ - 24 hr) and cycloheximide. A concentration of 10.0 $\mu\text{g}/\text{ml}$ of cycloheximide reduced chitin synthesis by 60% and protein synthesis (H^3 -leucine incorporation into TCA-precipitable material) by 80%. These results suggest that protein-synthesis during the ecdysone-dependent period is necessary for subsequent chitin synthesis.

Plans: Evaluate the competence of wing disks from various developmental stages to produce chitin in vitro with or without β -ecdysone. Examine the relative incorporation rates for various chitin precursors.

Maintenance of the Sex Pheromone Gland of the Indian Meal Moth
Plodia interpunctella in Tissue Culture

G. S. Asokasrinivasan¹, J. A. Coffelt and H. Oberlander

(Continuation of report 03 77(7-12))

Objectives: To establish an in vitro culture system for the female sex pheromone gland (SPG) of the Indian meal moth.

Methods: SPGs were isolated from donors of different age groups. The donors were surface sterilized by soaking them for 15-20 min in 0.1% mercuric chloride solution to which Triton-X had been added. They were then washed in sterile distilled water and allowed to dry before the abdominal tips were isolated. The tips were freed of most of the attached gut, oviduct and other tissues, rinsed in sterile medium and cultured in 1 ml of either modified or chemically defined Grace's medium at 25°C. Following the incubation period the glands were either fixed in Bouin's solution and prepared for histology, or the glands and medium were extracted for pheromone. Pheromone titer was based on a bioassay in which a 10-fold change in concentration of pheromone resulted in ca. 20% change in male response.

Results: Histological studies showed that SPG cells from either 2-day-old virgin females or -1 day pharate adult females that were cultured in either modified or chemically defined Grace's medium (but not insect Ringer's solution) for up to 10 days were indistinguishable from freshly dissected glands. In contrast 10-day-old glands in vivo have begun to degenerate as the adult approaches senescence. The quantity of pheromone in the SPGs from 2-day-old females diminished during incubation, and little pheromone was extracted from the glands after 6 days of culture. On the other hand, significant amounts of pheromone were extracted from the gland's incubation medium -- 100x more pheromone from the modified than from the chemically defined medium. SPGs from pharate adult females did not contain pheromone, nor did they produce any after culture in vitro for 6 days.

Plans: Pharate adult SPGs will be cultured with various hormone combinations to induce differentiation and/or pheromone production.

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Reproductive Biology of Lasioderma serricorne (Fab.r)

J. A. Coffelt, D. L. Silhacek and W. T. McClellan

(Continuation of report 04 77(7-12))

Objectives: These studies are part of a continuing series of investigations of the reproductive biology of Lasioderma serricorne. The specific objectives during this reporting period were to confirm the presence of behaviorally active extractable components in commodities commonly infested by this species.

Methods: Aggregation bioassays (methods described in report 07 76(7-12)) were conducted with various fractions of host material (paprika and tobacco) following chromatography on silicic acid. Hexane, hexane:ethyl ether mixtures, ethyl ether, acetone and methanol were used as eluting solvents. Forty-five fractions were collected in each run.

A second series of bioassays using the above described fractions were made to detect the possible presence of chemical oviposition stimuli. Treated and untreated (control) black filter paper squares were used as oviposition sites.

Results: Significant aggregation (relative to controls) was associated with silicic acid fractions 1-3 with both host materials. A second area of aggregation activity was associated with fractions 12-22, again with either host material. Host (paprika or tobacco) materials that eluted beyond fraction 22 did not elicit aggregation. This result suggests that the same or similar compounds are present in both host materials and are responsible for eliciting the aggregation behavior. Oviposition assays showed that only fraction 14-16 (paprika) and 19-21 (tobacco) resulted in significant increases in oviposition relative to untreated oviposition sites.

Plans: We will prepare a manuscript describing the work to date and attempt to quantify the present bioassay i.e., evaluate the aggregation and oviposition responses as a function of extract concentration.

Biochemical Resistance of Citrus to Attack
by the Caribbean Fruit Fly

P. Greany, P. Davis¹, S. Correale² and R. Merkhofer²

(Continuation of report 08 77(7-12))

Objectives: To determine the effect of citrus peel oil constituents and chemical analogs on survival of Caribbean fruit fly eggs and larvae.

Methods: The method described in the previous report for in vitro bioassay of citrus allelochemicals and related compounds has been altered slightly. Rather than to use peanut oil as the diluent, mineral oil purified by Florisil column chromatography has been substituted because of its relative chemical inertness and consequent decreased chance of chemical interactions between the test agent and the diluent and potential synergistic effects deriving from these interactions.

Results: Tests on the effect on larval survival of each of the major terpenoid constituents of the oils of lemon, orange, and grapefruit have nearly been completed. Similar tests on the egg stage are nearing completion also. The results are generally comparable to those described previously using peanut oil as a diluent. The data are being analyzed and two manuscripts are in preparation.

Plans: To conduct bioassays on chemical analogs of the most active compounds (see previous report). Bioassays of selected compounds against the eggs and larvae of wild Caribbean fruit flies are planned for August and September.

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²Graduate Student, Department of Entomology, University of Florida, Gainesville, FL.

Relationship Between Fruit Senescence and Fruit Variety
to Suitability of Citrus for Attack by the Caribbean Fruit Fly

P. Greany, P. Davis¹, P. Shaw², S. Correale³, and R. Merkhofer³

(Continuation of report 09 77(7-12))

Objectives: To elucidate the basis for increased susceptibility of senescent citrus fruit to attack by the Caribbean fruit fly, and to define the biochemical and morphological reasons for differential resistance observed among citrus varieties and species to attack by the Caribbean fruit fly.

Methods: The techniques employed are described in the previous report.

Results: The resistance of temple oranges to successful attack began to break down in December 1977, and the number of flies produced per fruit increased further as the fruit matured. Eureka and Lisbon lemons retained their immunity to attack even when so ripe as to be ready to drop from the tree. Grapefruit (pink and white) became increasingly susceptible as they became senescent.

Bioassays of the peel oils of each type of fruit indicated little difference in the toxicity of orange and grapefruit oils to the eggs and larvae of the Caribbean fruit fly, irrespective of the maturity of the fruit from which the oils were derived. In contrast, lemon oil appeared to be more toxic, especially to the fruit fly larvae, than that of either oranges or lemons. These results and those of the analyses described in the previous report are being analyzed and a manuscript is being prepared.

Plans: To determine whether the susceptibility of citrus fruit may be manipulated by use of plant growth regulators and to further define the basis for the pronounced resistance of lemons.

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²Research Chemist, USDA Citrus Laboratory, Winter Haven, FL.

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Insect Growth Regulators to Control Almond Moth
in Inshell Peanuts

D. A. Nickle¹

(Continuation of report 12 77(7-12))

Objective: To evaluate the efficacy of candidate insect growth regulators as control agents of the almond moth, Ephestia cautella, in inshell peanuts.

Methods: Four insect growth regulators, TH6040 (Thompson-Hayward), ZR512 (Zoecon), ZR515 (Zoecon), and MV-678 (Stauffer), were sprayed on inshell peanuts. Concentrations of each IGR ranged from 0.01 to 200 ppm. Peanuts were placed with 200 eggs into screen-top gallon jars, and emerging adults from each treatment were removed daily and counted as a measure of suppression. To evaluate sublethal effects of the IGRs, individual fecundity of adults from each treatment was measured.

Results: It was demonstrated that insect growth regulators at concentrations comparable to those used with insecticides like malathion, may suppress almond moth populations on inshell peanuts. Except for TH6040, which did not demonstrate a dose-mortality relationship, 3 IGRs produced 50% mortality at concentrations below 30 ppm, and 90% mortality at concentrations below 100 ppm. Since recent studies with TH6040 in laboratory rearing medium did show a dose-mortality relationship in almond moth larvae, it is suggested that for some reason TH6040 is not effective as a control agent on inshell peanuts as a commodity.

Sublethal effects on fecundity occur for all 4 IGRs. MV-678 shows great promise as an inhibitor of reproduction.

Plans: Replication of this study is complete and the study is being prepared for publication. Mode of action of MV-678 as a sterilant will be examined, and bioassays may be made on pheromone production in IGR-treated E. cautella.

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Effects of Insect Growth Regulators on Survival
and Reproductive Success of Bracon hebetor, a
Parasite of the Almond Moth, Ephestia cautella

D. A. Nickle¹ and D. W. Hagstrum

(Continuation of report 13 77(7-12))

Objective: To measure the ability of the parasite Bracon hebetor to survive and reproduce in an environment treated with insect growth regulators for the suppression of adult almond moth (Ephestia cautella) populations.

Methods: Four IGRs were evaluated at 3 concentrations: ZR512 (Zoecon), ZR515 (Zoecon), TH6040 (Thompson-Hayward), and MV-678 (Stauffer), all at 1, 10, and 50 ppm.

Parasites reared from IGR-treated E. cautella larvae at the above concentrations were used to parasitize both untreated larvae on clean peanuts and IGR-treated larvae on IGR-sprayed peanuts. The surviving offspring were counted and individual mated females were allowed to oviposit on clean hosts to measure sublethal effects on fecundity.

Results: Data from the first replication of this experiment suggest that (1) as the dose of 3 IGRs increases, fecundity (number of offspring/female) is reduced (ZR512, ZR515, and TH6040); (2) as the dose increases for 2 IGRs, percent survival to adult decreases (ZR512 and ZR515), and (3) one IGR, MV-678, has no apparent effect on survivorship or reproductive success of B. hebetor.

Plans: This project is near completion and a manuscript is being prepared. A study is now underway to combine IGRs with Bracon hebetor as a pest management strategy for suppressing almond moth populations. Tests are being initiated to adjust IGR concentrations to maximize the searching success of Bracon hebetor.

¹
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University of Florida, Gainesville.

Effects of Methoprene on Egg Production and Longevity in Virgin
Black Carpet Beetles, Attagenus megatoma (F.)

K. W. Vick

Objective: To determine the effects of exposure to methoprene on black carpet beetle reproduction.

Methods: Virgin black carpet beetle females were exposed to filter paper treated with methoprene with doses ranging from 10 to 900 $\mu\text{g}/\text{cm}^2$. Total eggs produced as well as longevity were determined for each female. Effect of female age when exposed and the effect of exposure time were also determined.

Results: Exposure of virgin black carpet beetle females to paper surfaces treated with methoprene resulted in egg development and oviposition. The magnitude of the oviposition responses was related to the amount of methoprene on the treated surface. The number of eggs laid was also related to the age of the female when exposed to the methoprene with young females laying substantially more eggs than older females. Egg production was induced by a methoprene exposure of only a few hours duration although maximum egg production required an exposure of longer than 24 hrs. Post-treatment longevity declined with increased treatment loads. Exposure of the females to the vapor from the treated paper discs resulted in as many eggs being produced as direct contact with the methoprene treated paper, although female longevity was reduced more by contact with the treated paper than by exposure to the methoprene vapor.

Plans: A paper describing this work is in preparation.

Factors Affecting the Sex Ratio of Apanteles marginiventris,
a Primary Parasite of the Fall Armyworm

T. R. Ashley

(Continuation of report 14 77(7-12))

Objective: To investigate the effects of photoperiod, light (intensity and quality), proportion of male to female parasites during mating, and temperature (constant and fluctuating) on the sex ratio of A. marginiventris.

Methods: Virgin male and female parasites were placed together in mating cages for various lengths of time, and then the females were removed and placed in individual plastic cups for exposure to hosts. This procedure permitted evaluating the various factors under investigation on both mating and oviposition. Female parasites were exposed to newly hatched fall armyworm larvae. The sex ratio of the progeny from each female was determined in order to ascertain the effects of the various factors during the mating and ovipositional periods.

Results: Initially only about 10% of the laboratory-reared parasites were females. Experiments dealing with light intensity raised this to 34% females. Additional studies dealing with the quality of light perceived during the mating and ovipositional periods have raised the proportion of female progeny to ca. 60%. Light quality has its greatest effect during the mating period. However, there is some indication that it may also be important during the ovipositional period.

Plans: Further experiments are planned to define more precisely those wavelengths and light intensities that are responsible for influencing the sex ratio of this parasite.

Sex Determination of Carpenterworm Larvae

N. C. Leppla, J. D. Solomon¹, and W. J. Pons²

Objective: To develop practical dissection techniques for larvae of the carpenterworm, Prionoxystus robiniae Peck.

Methods: Carpenterworms reared in host trees at Stoneville, Mississippi, were extracted, preserved in 70% aqueous ethyl alcohol, and either dissected or fixed in alcoholic Bouin's solution. Histological sections were prepared by dehydrating whole larvae in an alcohol series, followed by clearing in methyl benzoate, further drying in benzene, and embedding in 56°C paraffin. Then they were cut into 6 μ sections and mounted on microscope slides. Tissues were differentiated with Mallory's triple stain.

Results: The kidney-like testes are exposed by entering the venter, removing the alimentary canal, and probing through the fat body along an imaginary line connecting the 3rd pair of abdominal prolegs. These paired gonads lie beneath the 5th tergite between the internal dorsal longitudinal muscles; the intersegmental fold between the 4th and 5th tergites bisects their anterior borders. They parallel the dorsal vessel and each is permeated by an abundance of trachea from the proximate spiracle. A single vas deferens originates at the posterior margin of each gonad and terminates in the distal region of the 10th segment. Each testis is composed of 4 distinct lobes that project ventrally and average 0.3 mm in length. The entire fixed and stained organ is 1.4 mm long, 0.5 mm wide, and 0.33 mm depth.

The ovaries are situated in the same relative position as the testes; however, the female gonads are less distinct and more closely associated with the fat body. The oviducts appear to enter tracheal branches in the 7th abdominal segment. Ovaries are more triangular than testes and proportionally larger. Average body lengths, head widths, gonad lengths, and gonad depths were 49.0 ± 1.2 , 4.4 ± 0.1 , 2.3 ± 0.2 , and 1.1 ± 0.1 mm for males and 66.0 ± 1.5 , 5.7 ± 0.1 , 5.1 ± 0.8 , and 1.6 ± 0.1 mm for females, respectively (n=4 and 3 σ).

Plans: The study has been completed and a manuscript is being prepared.

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Sterile Males in a Sex Pheromone Permeated Atmosphere to
Reduce Reproduction of Ephestia cautella

D. W. Hagstrum, J. P. McLaughlin, B. J. Smittle, and J. A. Coffelt

Objective: To investigate the cornutability and the potential benefits of the combination of the sex pheromone permeated atmosphere and the sterile male release technique as a means of reducing almond moth reproduction.

Methods: A 0.2 m³ cage stocked with 1, 5, 10 or 15 virgin E. cautella pairs also contained either or both 2, 10, 20 or 30 irradiated males (50 kR) or sex pheromone permeated atmosphere. At the end of the 24-h test period, the females were collected individually in vials, held another 24 h for oviposition and then dissected for transferred spermatophores. The percent hatch was determined for the eggs laid by each female so that the mating could be scored as sterile or fertile.

Results: A combination of the sex pheromone permeated atmosphere (SPPA) and sterile males in a ratio of 2 sterile:1 fertile can reduce reproduction 40% more than either of these treatments alone. The sterile males render infertile some of the matings that occur in the SPPA. Thus, sterile males may be an important adjunct to SPPA in situations in which moth density is too high for SPPA to prevent mating and may be particularly important in dealing with 'hot spots' of high population density.

Plans: The concept will be investigated further with populations having a nonuniform distribution.

Provisioning with Pre-paralyzed Hosts to Improve
Parasite Effectiveness: A New Pest Management
Strategy Against Almond Moth in Stored Peanuts

D. A. Hinkle¹ and D. W. Hagstrum

Objective: To enhance effectiveness of Bracon hebetor in suppressing almond moth populations by providing female parasites with pre-paralyzed hosts that serve both as adult food sources and alternate oviposition sites.

Methods: Peanuts were placed on 36 sample squares in 3 rooms (5.9 m x 5.9 m x 2.4 m). To produce a continuous population of the almond moth, eggs were placed on each square at a rate of 1 egg per day until the first adult appeared in the rooms. The rooms were treated as follows: Room 1, labeled 'parasites only,' in which 2 releases on 50 pairs of parasites were made at 14 and 21 days after the experiment began; Room 2, 'parasites plus provisioned hosts,' treated the same as room 1 except that 5 paralyzed hosts were placed on each square (n=180); and Room 3, 'Control,' in which no parasites were added, and the almond moth was allowed to develop unchecked. Hosts are easily paralyzed in the laboratory by exposing them to starved parasites for 3 hours. The parasites will paralyze them but have no supply of eggs available to oviposit on them. Weekly counts were made of both living and dead Bracon and Ephestia. At the end of the experiment 6 sample squares from each room were sampled for feeding damage.

Results: The results showed that (1) provisioning with pre-paralyzed hosts facilitated rapid Bracon population increase, (2) the numbers of moths in the 'parasites only' treatment and in the 'parasites plus provisioned hosts' treatment were 5- and 10-fold lower, respectively, than in the Control, and (3) damage to peanuts was significantly reduced in the treatment where provisioning with hosts occurred.

Plans: The experiment is nearly complete and a manuscript is being prepared. The same principle will be tested again in the same rooms, except that instead of provisioning with pre-paralyzed hosts insect growth regulators sprayed on the peanuts will provide Bracon with a continuous source of available hosts.

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Genetics of Medfly Colonization

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Insect Attractants Laboratory

N. C. Leppla
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Objective: To identify environmental factors that may cause excessive mortality and therefore produce genetic bottlenecks or other selective effects during initial colonization of wild-type Mediterranean fruit flies, Ceratitis capitata (Wiedemann).

Methods: Medfly pupae were obtained from field-collected peaches and used to establish 3 independent colonies (Figure 1). These colonies are being maintained as naturally as possible (TLC) eased into colonization by successive removal of normal stimuli (EED), or forced directly into production (FED). Each treatment is replicated 3 times, with 55 pairs in each of 3 cages for each strain. The TLC and FED colonies are being reared on papaya fruit for several generations, then the EED strain is to be given an artificial diet and oviposition substrate. Life history data (fertility, fecundity, rate of development, and survival to reproductive age) and behavioral performance are being recorded for each generation (P_1 to F_{10}). Specimens also are being preserved for isozyme analysis.

After a 12-day maturation period for the P_1 flies, papaya or punctured plastic vials were placed in each cage for oviposition and exposed for 24 hours. The papaya were removed, eggs from the vials were transferred to diet, and both were held for larval development. On the same days that these oviposition substrates were provided, 5 females were removed from each cage, held individually for 24 hours with papaya rinds (TLC and EED) or plastic vials (EED), and returned to their respective cages. Eggs from these samples were counted, held 3 days to determine hatch, and discarded.

Results: Approximately 87% of the field-collected pupae were viable and, regardless of colonization procedure, their productivity was essentially equivalent (Table 1). There were no statistically significant differences in the rates of survival and oviposition, egg hatch, or pupal yields. Results were slightly more variable for the TLC and EED strains, but all 3 produced about the same number of F_1 flies.

Plans: This research will continue in an effort to identify developmental and behavioral differences in subsequent generations.

Figure 1.-- Flow Chart for Medfly Colonization Experiment

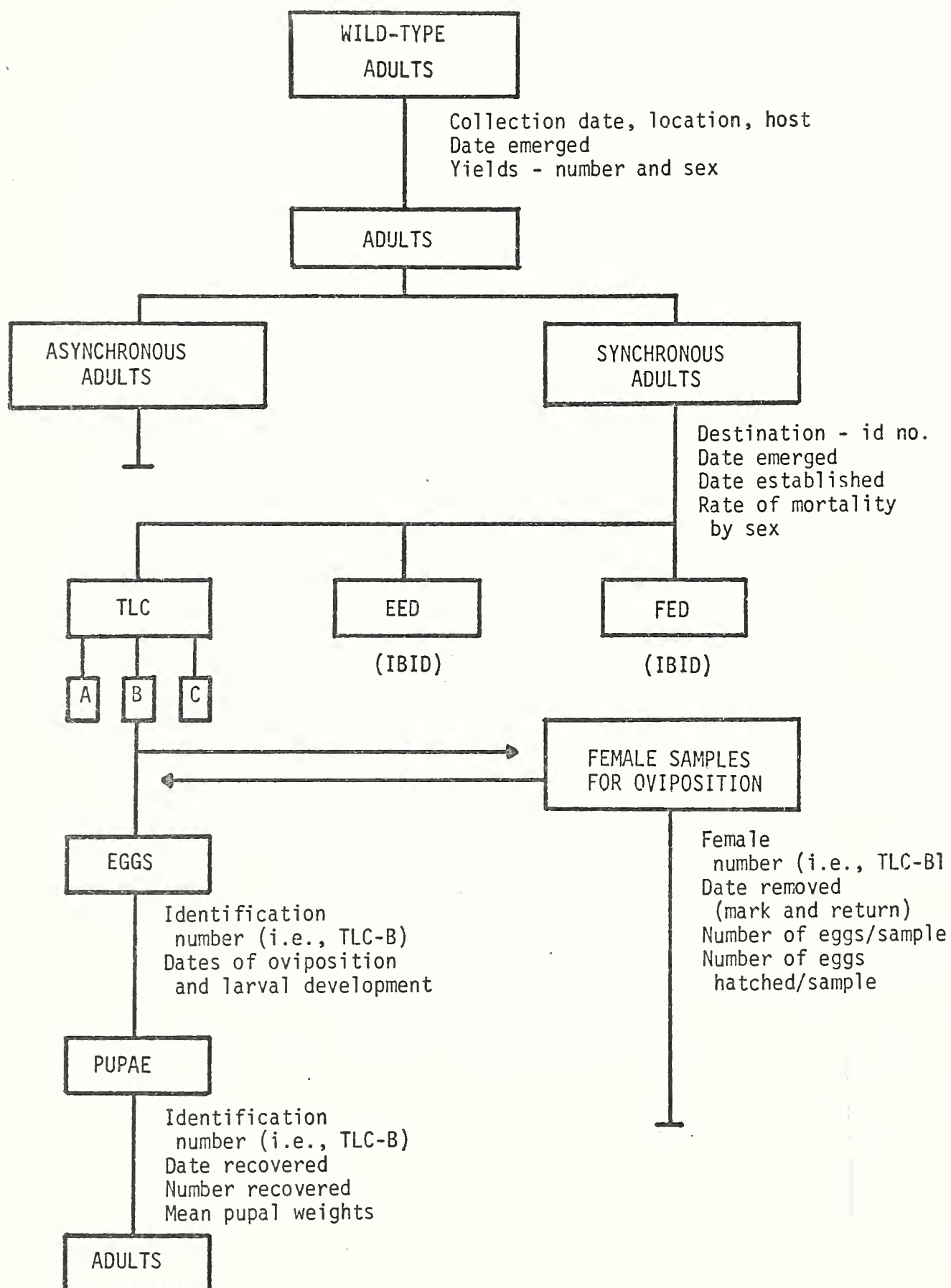


Table 1. Life history data for P₁ flies and their progeny.

Parameter ^{1/}	Strain		
	TLC $\bar{x} \pm SE$	FED $\bar{x} \pm SE$	FED $\bar{x} \pm SE$
Female survival			
day 12	52.0 \pm 0.6	52.0 \pm 0.0	50.3 \pm 0.3
14	45.3 \pm 1.5	43.3 \pm 1.8	43.0 \pm 2.0
17	39.3 \pm 0.9	36.3 \pm 1.8	35.0 \pm 2.1
19	34.3 \pm 0.9	25.7 \pm 2.6	27.3 \pm 1.5
22	27.3 \pm 2.3	20.7 \pm 2.3	23.7 \pm 0.9
Eggs/ovi- positing ²	24.4 \pm 5.4	19.9 \pm 5.3	21.0 \pm 0.7
% hatch	63.3 \pm 13.1	55.9 \pm 17.7	85.7 \pm 7.0
Pupae/collection	51.8 \pm 16.4	49.9 \pm 27.0	56.3 \pm 7.6

^{1/} The number of viable eggs per ovipositing female was determined by sampling 5 flies for each strain and replicate on the indicated days (collections).

¹³C NMR Analysis of Octahydroindolizines

P. E. Sonnet, D. Netzel¹, and R. Mendoza²

Objective: To synthesize and examine by ¹³C NMR compounds related to the attractant isolated from Pharaoh's ant, Monomorium pharaonis L., namely 3-butyl-5-methyloctahydroindolizine.

Methods: Synthetic methods previously reported upon (P. E. Sonnet and J. E. Oliver) were modified accordingly to provide samples of the parent ring compound with alternate substituents and with geometry that of the natural attractant (all-cis). ¹³C NMR and ¹H NMR, specific deuteration, T-1 measurements, variable temperature, etc., were then employed to aid in ¹³C shift assignments.

Results: Assignments were made for the four geometrical isomers of the named structure as well as for the newly synthesized analogs. Key shifts are markedly different for each isomeric structure, and an effort was made to assign conformation to the four isomers based on these shifts.

Plans: No further work is planned on Pharaoh's ant.

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Stable Fly Cuticular Chemistry

P. E. Sonnet

Objectives: To synthesize the four geometrical isomers of 1,7,13-pentacosatriene, a compound carried by male stable flies. The compounds bear further biological investigation; their synthesis is a natural springboard for demonstrating the utility of newly developed synthetic techniques for pheromone synthesis.

Methods: Synthetic methods which were conventional were applied in order to obtain the Z,Z- and the Z,E-isomers. Each of the two isomers was then exposed to newly developed sequences of synthetic operations designed to invert Z,Z to E,E and Z,E to E,Z.

Results: The inversion sequence involving tris-epoxidation followed by 1) $\text{Ph}_3\text{P}-\text{Br}_2$, 2) Zn successfully converted Z,Z to E,E. The sequence involving tris-epoxidation followed by 1) trifluoroacetyl chloride, 2) NaI converted Z,E to E,Z.

Plans: No further work on stable fly is envisioned.

Synthesis of Pheromones and Pheromone-Like Compounds
by New Stereoselective Routes

R. F. Doolittle, R. P. Heath, and G. Burnsed

(Continuation of report 17 77(7-12))

Objective: In view of the difficulties encountered in the preparation of sufficient amounts of lesser peachtree borer pheromone (E,Z-3,13-ODDA) in a state of purity acceptable for field testing programs (i.e., low enough in Z,Z isomer content), new innovative methods for preparing and/or purifying the pheromone are needed. The objective of this project is to develop new stereoselective synthetic methods and to adopt such methods as are already established for the synthesis of this pheromone. In addition, new and innovative methods for the stereoselective synthesis of other pheromones will be investigated and applied where possible.

Methods: An analytical method (utilizing capillary gas liquid chromatography, Heath and Burnsed) was developed to evaluate the stereochemical outcome of the new synthetic procedures being applied to the E,Z-3,13-ODDA problem. This method provides for the rapid and accurate analysis of the products that will result from the stereoselective synthesis of E,Z-3,13-ODDA and any model compounds that are generated in this project.

Results: We have found that the stereochemistry of the reduction of homopropargylic alcohols to homoallylic alcohols is influenced by a number of factors. The outcome of the dissolving metal reductions with sodium or lithium depend on the metal used and the co-solvent. The effects have not been reported before. The reduction has been accomplished with another reducing agent under conditions much milder than previously reported. Unfortunately, this method does not yield homoallylic alcohols of high enough stereochemical purity to indicate its use in preparing E,Z-3,13-ODDA would be successful. The stereochemistry of another method of preparing homoallylic alcohols directly from terminal acetylenes was investigated and results were obtained which differed markedly from those reported by other workers. Most of the studies conducted thus far have been on model compounds since the homopropargylic alcohol needed for the E,Z-3,13-ODDA synthesis was not available. This compound has now been synthesized in sufficient quantity to apply the methods of reduction thus far only investigated in model systems. Several intermediates needed for the C-O cleavage reaction investigation have been synthesized.

Plans: Any method that can be found or postulated for the stereospecific preparation of homoallylic alcohol will be looked into carefully for possible application to the synthesis of E,Z-3,13-ODDA. The best reduction method found thus far will be applied to the homopropargylic precursor to E,Z-3,13-ODDOL and the product evaluated both biologically and analytically.

New stereospecific and stereoselective routes to other pheromones will be investigated when time permits.

Isolation and Identification of the Oviposition Detering Pheromone
of Rhagoletis pomonella

J. H. Tumlinson, P. J. Prokopy¹, D. L. Chambers, and M. M. Brennan

Objective: To isolate, identify, and synthesize the oviposition detering pheromone produced by female Rhagoletis pomonella.

Methods: The methanol washes (see previous reports) have been distilled and fractionated by chromatography on silica, reverse phase, and gel permeation columns. Bioassays to monitor the various concentration and purification procedures are conducted by Prokopy in Massachusetts.

Results: Because of problems with the flies and shortage of labor for bioassays, progress has been slow. Preliminary results indicate there are at least two components, one of which is somewhat volatile.

Plans: Proceed to isolate, identify, and synthesize the pheromone and to test it for biological activity in the field. Various LC procedures will be thoroughly investigated to develop a purification technique.

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Isolation and Identification of the Imported Fire Ant,
Solenopsis invicta Buren, Queen Pheromone

J. R. Rocca, J. H. Tumlinson, B. M. Glancey¹, C. S. Lofgren¹ J. H. Tumlinson
A. Glover¹, and S. Mitchell¹

(Continuation of report 21 77(7-12))

Objectives: Isolation, identification, and synthesis of the pheromone produced by *S. invicta* queens and its incorporation into a control program for this pest.

Methods: Two bioassays are presently in use; one for "volatile" substances, is a slightly modified version of the more recently described bioassay (see previous reports). The other, also a modified form of an older bioassay (see previous reports), for "non-volatile" substances in which samples are applied to small wooden sticks or uniformly cut rubber septa serving as "surrogate queens" to workers and allowing for the possibility of a contact or less volatile component of the pheromone. Benzene extracts of whole queens (over 20,000 queens have been extracted) can be concentrated and biologically active material distilled under vacuum (0.01-0.02 Torr, 90-95°C) onto a liquid nitrogen cooled condenser. Distillate, pot residue, and crude extract have each been fractionated by gravity elution from silica and by gas chromatography (g.c.) on OV-101 (100-250°C). Low pressure gel-permeation chromatography (see previous reports) has been abandoned as a purification method for the present.

Results: Concentration-activity curves have been constructed for crude extracts using both bioassays; extracts show typical logarithmic, sigmoidal dose-response curves. The pheromonal substances appear to be stable to light, heat, and chromatography on silica. Preliminary results from collections of g.c. fractions of the distillate described above indicate the existence of at least two "volatile" substances. The residue, however, also appears to contain less volatile material which may be necessary to completely reconstruct the "queen response" by workers to surrogate queens.

Plans: Biologically active materials will be purified further, probably with emphasis on the "volatile" substances. Identification and synthesis will begin as pure compounds are obtained.

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Isolation and Identification of the Sex Pheromone
of the White Peach Scale

R. R. Heath, J. R. McLaughlin, J. E. Tumlinson, and T. R. Ashley

(Continuation of report 16 77(7-12))

Objectives: As part of a program to develop an integrated pest management system for peach insects, the sex pheromone produced by the female white peach scale, Pseudaulaspis pentagona, will be isolated, identified, synthesized, field tested, and incorporated into survey and control programs.

Methods: The pheromone was isolated and purified by liquid and gas chromatography, identified by spectroscopy and micro-analytical methods, and synthesized. The isolation, identification, and synthesis were monitored by a field bioassay.

Results: (R,Z)-3,9-dimethyl-6-isopropenyl-3,9 decadien-1-yl propionate, isolated from the female, is the pheromone that attracts male white peach scale. Initial laboratory and greenhouse bioassays showed the R,Z isomer was active. No synergism or inhibition occurred when various combinations of the (R,E), (S,E), and/or (S,Z) isomers were added to the active R,Z material. The (R,Z) enantiomer can be synthesized stereoselectively. Methods and techniques for improving the original synthesis are being investigated in this laboratory as well. A manuscript describing the isolation, identification, and synthesis of this pheromone has been submitted to the Journal of Chemical Ecology.

Plans: The pheromone will be synthesized and formulated for field testing this fall.

Sex Pheromone Studies of the Navel Orangeworm

J. A. Coffelt, F. W. Vick, P. Sonnet and R. E. Doolittle

(Continuation of report 21 77(1-6))

Objectives: To isolate and identify the female sex pheromone of the navel orangeworm, and to determine the physiological, behavioral, and environmental factors that influence male response to, and female production of the pheromone.

Methods: Quantitative laboratory bioassays (activation and attraction) were conducted using all 4 possible geometric isomers of the pheromone. Mixtures of isomers were also bioassayed (activation test only). Also bioassays (both types) were conducted using 2 pheromone analogs.

Results: Only one of the 4 geometrical isomers elicited significant activation and attraction responses by navel orangeworm males in laboratory bioassays. Quantitative comparison of the responses to the synthetic pheromone were not significantly different from that obtained with similar concentrations of the natural product. Mixtures of all 4 isomers did not alter male activation response relative to the one active isomer alone. The 2 pheromone analogs were not active, either in terms of activation or attraction.

Plans: Conduct preliminary field tests with cooperating entomologists. The limited quantity of available pheromone precludes extensive field testing in 1978. Establish release characteristics of the pheromone and measure female pheromone release rates.

A Pheromone of the Japanese Beetle, Ponillia japonica Newman

R. E. Doolittle, J. W. Tunlinson, M. G. Klein¹, and T. L. Ladd¹

(Continuation of report 23 77(7-12))

Objective: Isolation, identification, and synthesis of the pheromone produced by the female Japanese beetle and its incorporation into an integrated control program for this pest.

Methods: The pheromone has been identified and synthesized (see previous reports). Because commercial companies failed to deliver pheromone that had been ordered, sufficient pheromone for the 1977 and 1978 field tests was synthesized in this lab. A total of 4 batches was produced and in every case the optical rotation of the R,Z-furanone was greater than -69°. Chemical Samples Company did deliver one 12-g batch that met specifications in the fall of 1977, but analysis of 4 other batches produced by this company have shown the product to be far below specifications. The pheromone synthesized in this laboratory and the one good batch from Chemical Samples have been formulated in Percon plastic strips and Conrel hollow fibers and field tested in North Carolina and Ohio.

Results: Field tests showed that the pheromone batches that were inferior by chemical analysis did not attract Japanese beetles in the field. All formulations of the good pheromone batches appear to work well in the field. Pheromone formulated in Conrel dispensers was used with eugenol/PEP in traps around California airports this year to monitor for introduced Japanese beetles.

Plans: Field and laboratory evaluation of various formulations of the synthetic pheromone will continue. An effort is being made to find a reliable commercial supplier of this pheromone. A technique to simplify the analysis of the optical purity of synthesized pheromone will be investigated.

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Chemical and Biological Studies of Sex Pheromone
of Stored Product Lepidoptera

J. A. Coffelt and K. W. Vick

(Continuation of report 24 77(7-12))

Objectives: To conduct basic chemical and biological studies to determine the role(s) of different environmental and physiological parameters that influence male response to, and female production and release of pheromone in stored-product Lepidoptera. The specific objective during the current reporting period was to complete the investigations of the influence of load on the release rate of synthetic pheromone from polyethylene vials.

Methods: Release rate studies (24 77(7-12)) were continued using Z,E-9,12-tetradecadien-1-ol acetate (ZETA). Release rates, as a function of initial loads of 0.01, 1.0, 10.0 and 100 mg were determined after 1, 4, 7 and 14 days. Tests were replicated 6 times.

Results: Collections have been completed and analyzed for the 10 and 100 mg loads. Collections for the 2 other loads have been completed, but have not yet been analyzed. The results to date suggest that the release rate obtained with the lowest load, 0.01 mg closely approximate the published release rate estimated for the female moth.

Plans: Complete release rate studies with ZETA. Prepare a manuscript that includes field data (trap catch) as a function of release-rate. Resume studies of the release characteristics of Z,E-7,11-hexadecadien-1-ol acetate at elevated temperatures. Continue mating disruption experiments with the Angoumois grain moth using a modified pheromone compound.

Development and Evaluation of Formulations
for Controlled Release of Insect Pheromones

J. H. Cross, J. H. Tumlinson, J. R. McLaughlin, E. R. Mitchell,
J. L. Sharp and T. S. Smith

(Continuation of report 37 76(7-12))

Objective: To develop methods to dispense pheromones in the field at known optimum release rates for extended periods of time. This will greatly increase the efficiency of pheromone utilization in insect monitoring and control programs.

Methods: Apparatuses to measure emission rates have been built and are being tested and optimized. They use the house vacuum to pull air through a filter into a flask, across a formulation, and onto a polymeric adsorbent that removes the pheromone from the air stream. After an appropriate length of time, the pheromone is eluted from the adsorbent and quantified by gas chromatography. Hollow fiber (Conrel) dispensers and laminated plastic (Hercon) dispensers both containing (Z,Z)-3,13-octadecadien-1-ol acetate (ZZODDA) are being aged in the field and aerated periodically to determine the release rate. During the flight period of the peachtree borers, dispensers from 1 to 6 months old will be tested for their ability to lure male borers to traps.

The release rate curves for Z-9-tetradecen-1-ol formate (ZOTDF) in chopped Conrel fibers have been determined roughly at room temperature and at 35°C. Release rates at the higher temperatures were measured by operating the apparatuses in a growth chamber.

Use of the apparatuses at elevated temperatures did not necessitate any modifications of the usual aeration procedure.

Plans: The ZZODDA aging experiment will be completed later in the summer. The release rates of ZOTDF from chopped fibers will be measured at 3 temperatures and closer intervals than before. The release rates of other commercial formulations of pheromones will be routinely screened to insure that they are suitable for field tests.

Pheromone Mimics

J. R. McLaughlin, R. E. Doolittle, J. Coffelt, and K. W. Vick

Objective: Recent disclosures have shown that compounds closely related to known sex pheromones and in most cases having certain structural similarities have produced an effect on the target species that appeared to mimic one or more of the behavioral effects of the true pheromones. These compounds have been called parapheromones.

Since researchers in this laboratory are currently involved with several insects possessing diene sex pheromones, which in most cases are difficult and consequently expensive to prepare, the use of combinations of monoenes in an attempt to mimic the activity of the diene sex pheromones seemed a logical project to undertake. In addition, the use of other types of compounds to mimic the activity of other selected pheromones that are difficult to prepare appears to be an area worthy of investigation. The fruit that these projects might bear would be the substitution of relatively inexpensive and readily obtainable monoenes for the scarce and expensive diene pheromones.

Methods: The requisite monoenes will be either purchased or synthesized and purified, and their purity determined. The pure compounds will be bioassayed for biological activity against the authentic sex pheromones.

The monoenes that would most likely mimic the activity of the Angoumois grain moth, Indian meal moth, almond moth, Mediterranean flour moth, southern armyworm, and beet armyworm will be obtained. In addition, the monoenes that would be pheromone mimic candidates for the sesiids (lesser peachtree borer and peachtree borer) will be obtained in pure form.

Results: The synthesis of several of the monoenes is well underway. The procurement of several of the other monoenes has been undertaken.

Plans: The requisite monoenes will be synthesized and purified, and those that are commercially available will be purchased and purified.

Attractivity to Synanthedon pictipes Males of
(E,Z)-3,13-Octadecadien-1-ol Acetate Evaporated
from Different Dispensers

J. L. Sharp, J. H. Cross, J. James

Objective: To determine differences in the attractivity of EZ-ODDA evaporated from different dispensers for Synanthedon pictipes males.

Methods: The dispensers evaluated were: (1) 5x9 mm rubber stoppers (replaced every 3 weeks with a fresh rubber stopper loaded with fresh pheromone), (2) 5x9 mm rubber stoppers impregnated with methylene chloride to absorb the pheromone, (3) 5x5x2 mm pieces of leather, (4) polyurethane foam cube (10³ mm) with <0.5 mm pore size, and (5) polyurethane foam cube (10³ mm) with 1 mm pore size. All dispensers were loaded with 500 µg EZ-ODDA (in hexane).

Fresh Pherocon 1C sticky traps with baited dispensers were distributed randomly and separated by at least 60 m in a peach-nectarine orchard near Lowell, FL. They were rotated in position and serviced 2-3x weekly. Every 3 weeks all traps were replaced with new ones. Then the dispensers were transferred from the old to the new traps, except for the rubber stoppers of treatment 1 (control) which were replaced with new rubber stoppers loaded with fresh pheromone. The experiment was repeated 3 times.

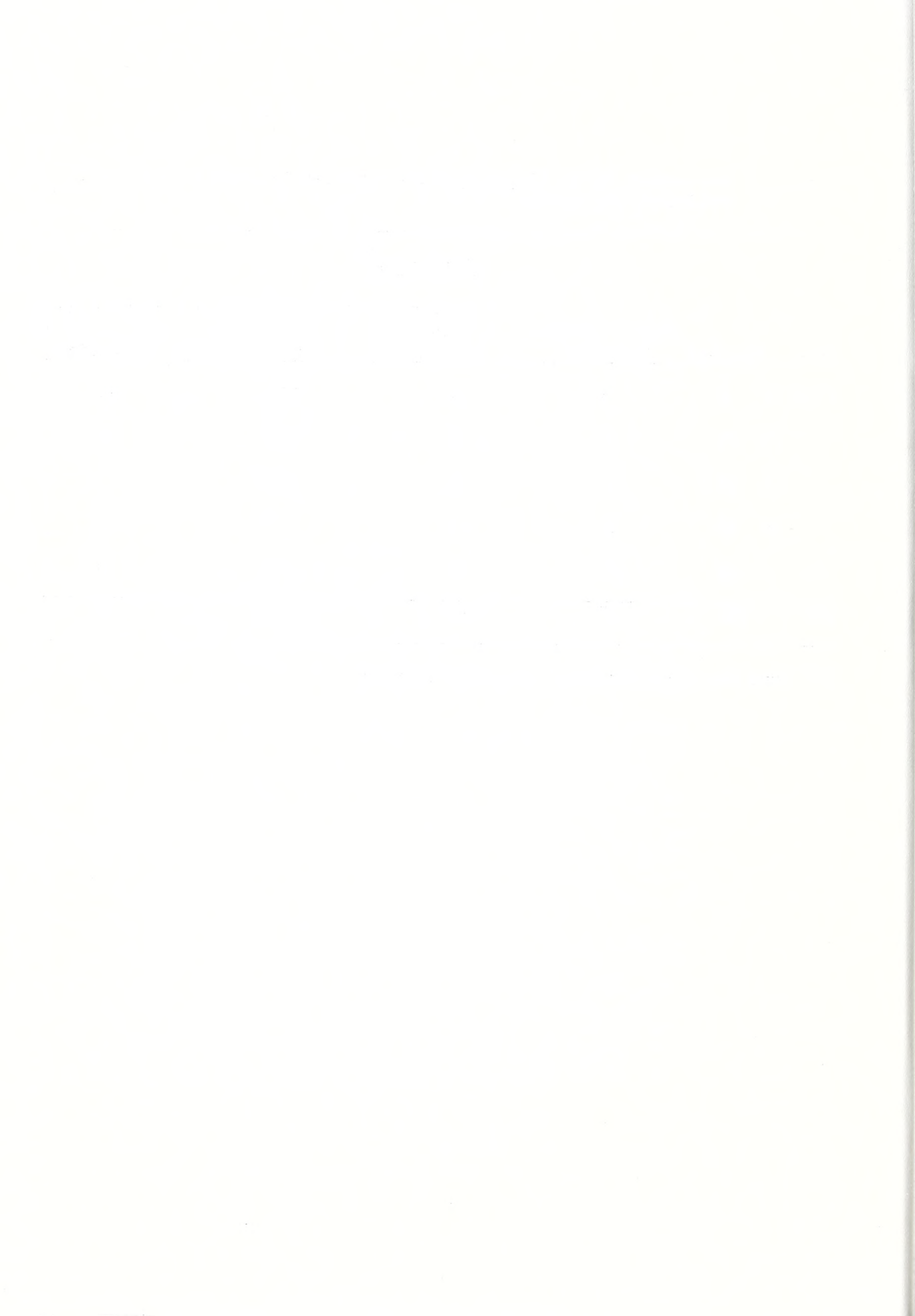
Results: The numbers of S. pictipes males captured in traps baited with EZ-ODDA evaporated from different dispensers are shown in Table 1. Initially the traps with polyurethane foams, which had the highest release rates, captured more male moths than the traps with other dispensers; but after 11 days no males were captured in traps baited with polyurethane foam. Release rates from the 2 polyurethane foams were ca. equal, 0.03 µg/hr per cube at room temperature (ca. 25°C). The release rate from the polyurethane foam with 1 mm pores was 0.5 µg/hr per cube at 35°C. Release rates from the leather and the 2 rubber stopper treatments were too low to measure.

Plans: At a release rate of 0.5 µg/hr per cube, the polyurethane foam should last 1000 hrs (42 days). Since they failed to capture any moths after 11 days, the pheromone in them probably oxidized. Foam cubes containing a 1:1 mixture of EZ-ODDA and an antioxidant, butylated hydroxytoluene, are now being tested. The duration of attractivity is being determined for a set of treatment 1 rubber stoppers. Tests with the treated leather pieces and rubber stoppers plus methylene chloride are continuing.

Table 1. The number of S. pictipes males captured in sticky traps with different dispensers.

Date	<u>Dispensers</u> ^{1/}				
	Leather	Rubber stopper (Control)	Rubber stopper & methylene chloride	Polyurethane foam 1 mm pore size	Polyurethane foam <0.05 mm pore size
6/16-19	5	3	5	176	36
-23	23	8	8	46	22
-27	44	20	5	35	3
-29	40	19	21	0	0
7/6	129	67	71	0	0
SUM	241	117	110	257	58

^{1/} Sums for each dispenser are from 3 traps



Fragrance and Flavor Modifiers in Formulations
of Pheromones and Toxic Baits

J. H. Cross and J. A. Coffelt

Objectives: Maltol, ethyl maltol, and methyl cyclopentanone modify human responses to a variety of pharmaceutical and cosmetic products. The modifications include increasing the fragrance impact of perfumes in talc and shampoo and masking the bitter taste of vitamins. This study was initiated to investigate the effect of these compounds on the responses of insects to pheromones, attractants, or toxic baits.

Methods: The volatility, solubility, and analysis of the compounds were investigated by standard chemical techniques. Male Trogoderma inclusum beetles were bioassayed by the usual shell vial bioassay. Solutions tested were: 1 part T. inclusum sex attracting pheromone to 1 and 100 parts of each of the 3 compounds; 1 part sex pheromone to 10,000 parts maltol; sex pheromone only (control).

Results: The compounds are solid, but maltol is roughly as volatile as a lower molecular weight pheromone such as Z-7-dodecen-1-ol acetate. Since they are soluble only in polar solvents, they probably will not diffuse through polyethylene, which is widely used to formulate pheromones. Pure maltol and its acetone solution discolor when exposed to air.

Trogoderma inclusum did not give any unusual responses to solutions of its sex pheromone with the fragrance modifiers. The 1:1 solutions showed no enhancement of response, and the 1:100 and 1:10,000 solutions showed neither enhancement nor inhibition.

Plans: The compounds are now being tested with the Japanese beetle lure and with fire ant toxic baits. They will be tested with one species of moth.

The Color Preference and Trapping of Vespula squamosa

J. L. Sharp and J. James

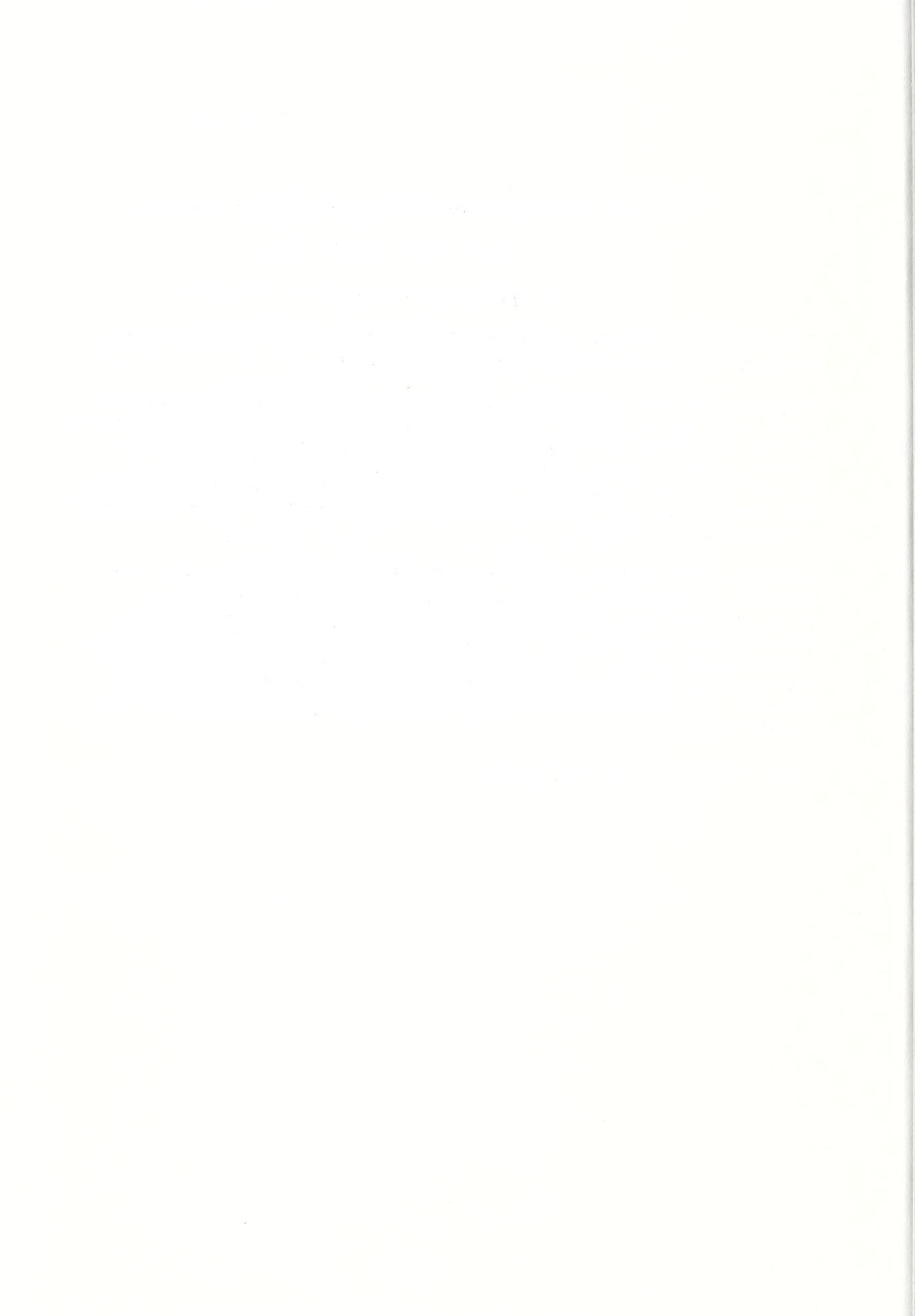
(Continuation of report 34 77(7-12))

Objective: To improve trapping methods for the yellowjacket Vespula squamosa by testing traps of different colors.

Methods: The most attractive plastic wet traps had tentatively been found to be those painted enamel colors, high gloss white and buttercup yellow, and those painted fluorescent colors, saturn yellow and arc yellow. Thus 4 traps, one of each color were placed within 15 cm of each other at 4 different locations in peach and nectarine orchards near Lowell, FL. The traps were checked and serviced 1-2 times weekly and rotated in position.

Results: From January 1978-June 1978, 2, 5, 9, and 10 workers were captured respectively in traps painted saturn yellow, high gloss white, arc yellow, and buttercup yellow. Also, 2, 4, and 4 queens were captured respectively in traps painted saturn yellow, arc yellow, and buttercup yellow. These tests confirm those in 1976-77 showing that buttercup yellow and arc yellow are the most attractive colors and that the yellowjackets are most attracted to the 580-590 nm wavelength region.

Plans: The tests are continuing.



Visual Sensitivity and Spectral Sensitivity of the Medfly,
Ceratitis capitata (Wiedemann)

H. R. Agee, J. C. Davis, D. L. Chambers, and E. F. Boller¹

Objective: Determine the visual and spectral sensitivity of the medfly from the Seibersdorf (IAEA) colony and a potential genetically marked strain (the Israeli apricot-eye) as part of a program to develop quality control technology for the large scale fruit fly rearing program in Latin America.

Methods: Visual sensitivity and spectral sensitivity instrumentation as described in earlier reports 47 76(7-12) and 38 74(1-6), respectively, was taken to the laboratory of Dr. E. F. Boller of the Swiss Federal Research Laboratory in Wädenswil, Switzerland, and made operational.

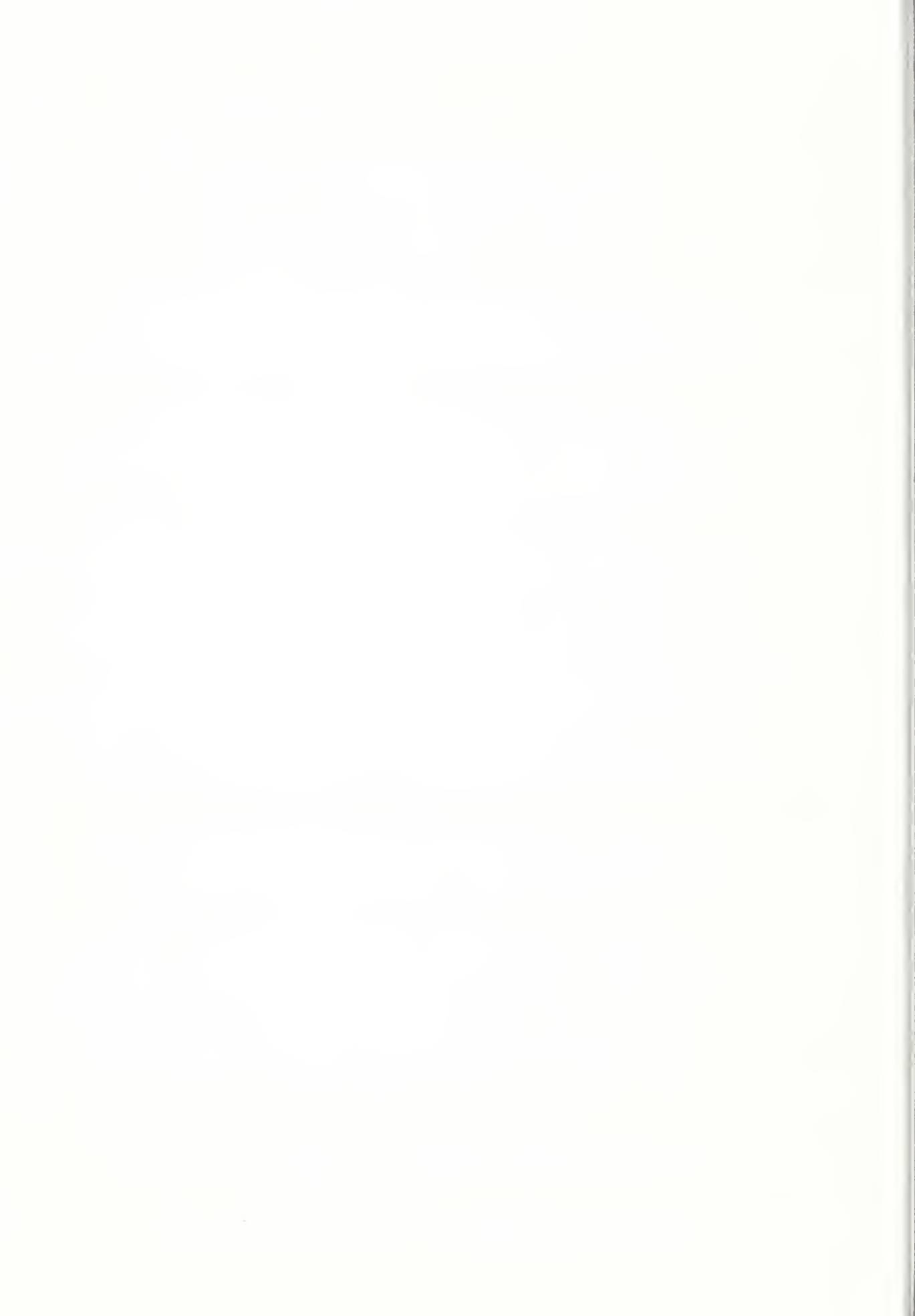
Results: Visual sensitivity and spectral sensitivity tests were conducted on 1- to 10-day-old irradiated medflies from the Seibersdorf colony during the first 2 weeks of May 1978. Three-day-old Seibersdorf medflies (irradiated and shipped as pupae) were tested; their visual sensitivity averaged 0.43 neutral density (ND) for a criterion (200 MV "on") response, which indicated they were much less sensitive than Seibersdorf flies (unirradiated) measured in December of 1975 at Seibersdorf (average visual sensitivity of 1.23 ND). Also the Seibersdorf flies were less sensitive than the apricot-eye Israeli medflies (unirradiated), which had a visual sensitivity that required neutral density filtering of 1.15 to maintain the criterion response. The Israeli flies compared favorably in visual sensitivity to the wild medflies of Hawaii, which required a ND of 1.20 to maintain the criterion response in December 1976.

The spectral sensitivity of the Israeli medflies was relatively lower in the UV end of the spectrum than other Diptera that have been tested. The Seibersdorf medflies were low in sensitivity throughout the spectrum.

Plans: Samples of wild medflies will be collected by 10-12 cooperators at their respective locations located around the Mediterranean Sea. They will be sent as a pupae to the central testing facility at Wädenswil, Switzerland, where the emerging medflies will be tested for visual and spectral sensitivity to establish the level of variability within the population. The information will be used as a reference for base-line comparisons with the laboratory-reared flies that are being released in SIT programs in a Mexican-American medfly program and for other quality assessment systems that are being developed and tested.

Additional studies will be made to determine the effects of genetic source, irradiation, and shipping on medfly vision.

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Insects Attracted to Black Lights and Burning Hydrocarbons

Philip S. Callahan

Objective: To compare the attractive properties of 15- and 6-watt BL traps with various burning hydrocarbon sources.

Method: Standard 4-baffle 15- and 6-watt black light traps were compared with the exact same baffle configuration with a Coleman lantern, kerosene lantern, alcohol lamp, and wax candle substituted for the BL bulb. The traps were each run for 3 nights between August 2 and September 5, 1977. Each hydrocarbon trap was checked every hour all night. The 5-day period of bright moonlight (full moon) was eliminated from the sequence. Insects were counted and identified as to family only. Moths were classified as micro (small) or macro (large) Lepidoptera. The test area was a three-quarter acre lot of mixed hardwood, open lawn, and vegetable garden (researcher's yard). The front porch light was also included for comparative purposes. Light intensities were measured with a Daystrom Weston Instrument foot candle meter or Ultra-Violet Product, Inc., long wave UV meter ($\mu W/cm^2 \times 100$). The results are given in table 1.

Results: Although the physical configuration of each trap was the same, there is no method by which the electromagnetic energy from the various sources can be equalized. The visible light from the Coleman lantern is over 1000 X that of the BL bulbs and 3000-4000 X that of the alcohol lamp. The measured emission (1 cm away) of the 3600° BL was 900 $\mu W/cm^2$ for the 15-W BL, 700 $\mu W/cm^2$ for 6-W BL, 600 $\mu W/cm^2$ for the Coleman lantern with glass mantle, and 1100 $\mu W/cm^2$ without the mantle. The paraffin candle emits 10 $\mu W/cm^2$, and the alcohol burner, 40 $\mu W/cm^2$. The kerosene lantern seemed to vary (according to the amount of wick sticking up) from 50 to 200 $\mu W/cm^2$.

Although the Coleman lantern without the mantle emitted 18% more intense black light than the 15-W BL bulb, it trapped only 2% as much as the 15-W BL, and 23% as much as the 6-W BL. The kerosene lantern and small alcohol lamp, which are very dim in the visible region and the BL region, trapped at least 50% as much as the powerful Coleman lantern. There is little doubt that the flickering (60-120 Hz for the BL) and 120 Hz, measured with an interferometer of the burning hydrocarbon sources is as important as the electromagnetic emission of hydrocarbons and black light. The Coleman lantern does not flicker. The candle was not comparable for it kept blowing out without a glass mantle, which would have eliminated the black light emission.

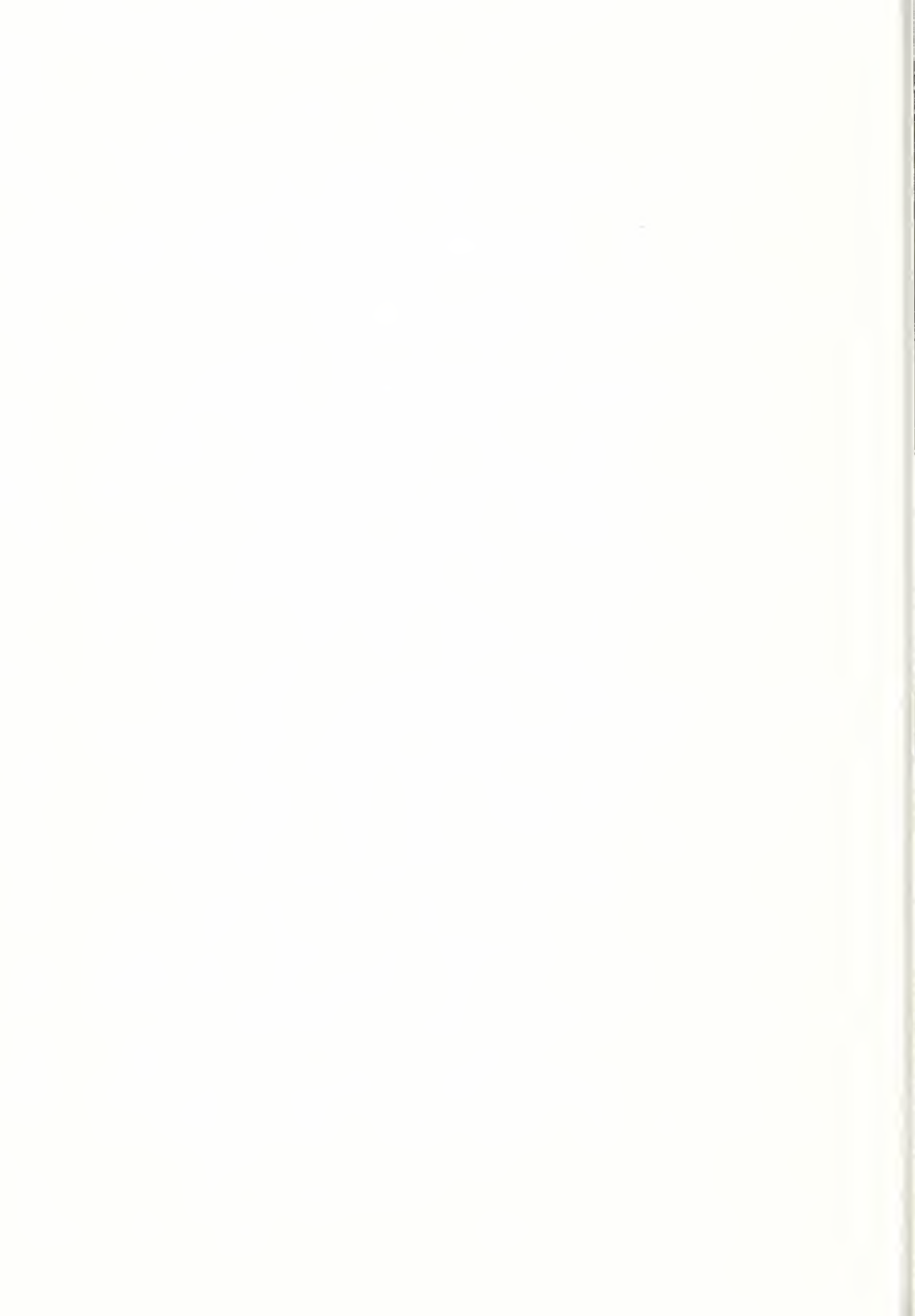
Plans: The same experiment is being replicated this summer.



Table 1. Number of insects caught at various black light and burning hydrocarbon traps (Aug. 2 - Sept. 5) and a porch light

Insect Family	15W (BL)	6W (BL)	Colman Light Without Mantle	Kerosene Lantern	Alcohol Lamp	Wax Candle	60W Porch Light
Large moth*	146	36	1	2			31
Small moths*	719	393	45	60	27	4	691
May beetles	16		2				1
Flower beetles							12
Click beetles	60	3	1	2			
Ground beetle	18						15
Long horned beetle	20						1
Diving beetles	12						
Darkling beetles	26	2	2				22
Soldier beetles	17		2		1		4
Bostrichid beetles	38						4
Weevils	5						1
Spittle bugs	104	2	4				3
Stink bugs	22						3
Plant hoppers	86		12	2			880
Wasps (Hymenoptera)	2	22				2	15 (6 large)
Queen ants	16	4					
Flys (Diptera)			34	6	24		15
Misc.	3550		5		5	10	6000
TOTAL	4857	462	108	72	57	16	7698

* Macro & Micro Lepidoptera



Effects of Temperature on the Signaling Sound of

Anastrepha suspensa (Loew)

J. C. Webb and D. L. Chambers

Objective: To determine the effects of temperature upon the signaling sound of the male Caribbean fruit fly.

Methods: Flies were reared in the laboratory under standard laboratory rearing procedures. All flies were from the same parent stock. When the flies emerged, they were sexed and 50 males were placed in each of 4 screened cages, then placed in a holding room and conditioned for 24-h before the test began. The flies were tested at 4 temperatures (70, 75, 80, and 85°F) with a light-dark cycle of 12 h. The signaling sound of 25 male flies was recorded. After the sound of a fly was recorded it was then placed in a separate cage and used again the following day. Tests were conducted at one temperature each day.

Results: The pulse train duration (PTD), pulse train interval (PTI), and the low frequency (F1) and high frequency (F2) components of the pulse trains were determined at each temperature, Table 1. Also the body weight and wing area, length and width, were determined for 25 flies, Table 1. The average frequency spectrum of 25 flies at each temperature is shown in Figure 1. Preliminary indications are that temperature influences the duration of a calling bout (PTD), but not the interval between bouts or the frequency composition of the call.

Plans: Plans are to run the experiment again and add an additional low and high temperature point. Also, the test will be duplicated at the same temperature, but one week apart to determine age effects.

Table 1. Means and \pm SE of the acoustical and physical properties of the call of the male Caribbean fruit fly at 4 temperatures.

Acoustical Properties

Temp °F	PTD	\pm SE	PTI	\pm SE	F1	\pm SE	F2	\pm SE
	ms	ms	ms	ms	Hz	ms	ms	ms
70	455	11.7	721	20.4	112	1.3	136	1.6
75	322	6.6	725	37.4	111	1.6	133	2.4
80	341	6.4	740	40.5	113	1.5	136	1.7
85	295	10.9	643	27.4	112	1.5	137	2.1

Physical Properties

Body Weight		Area mm^2		Wing		Width mm	
mg	\pm SE		\pm SE	Length mm	\pm SE		\pm SE
12.73	0.27	9.60	0.13	5.79	0.05	2.27	0.017

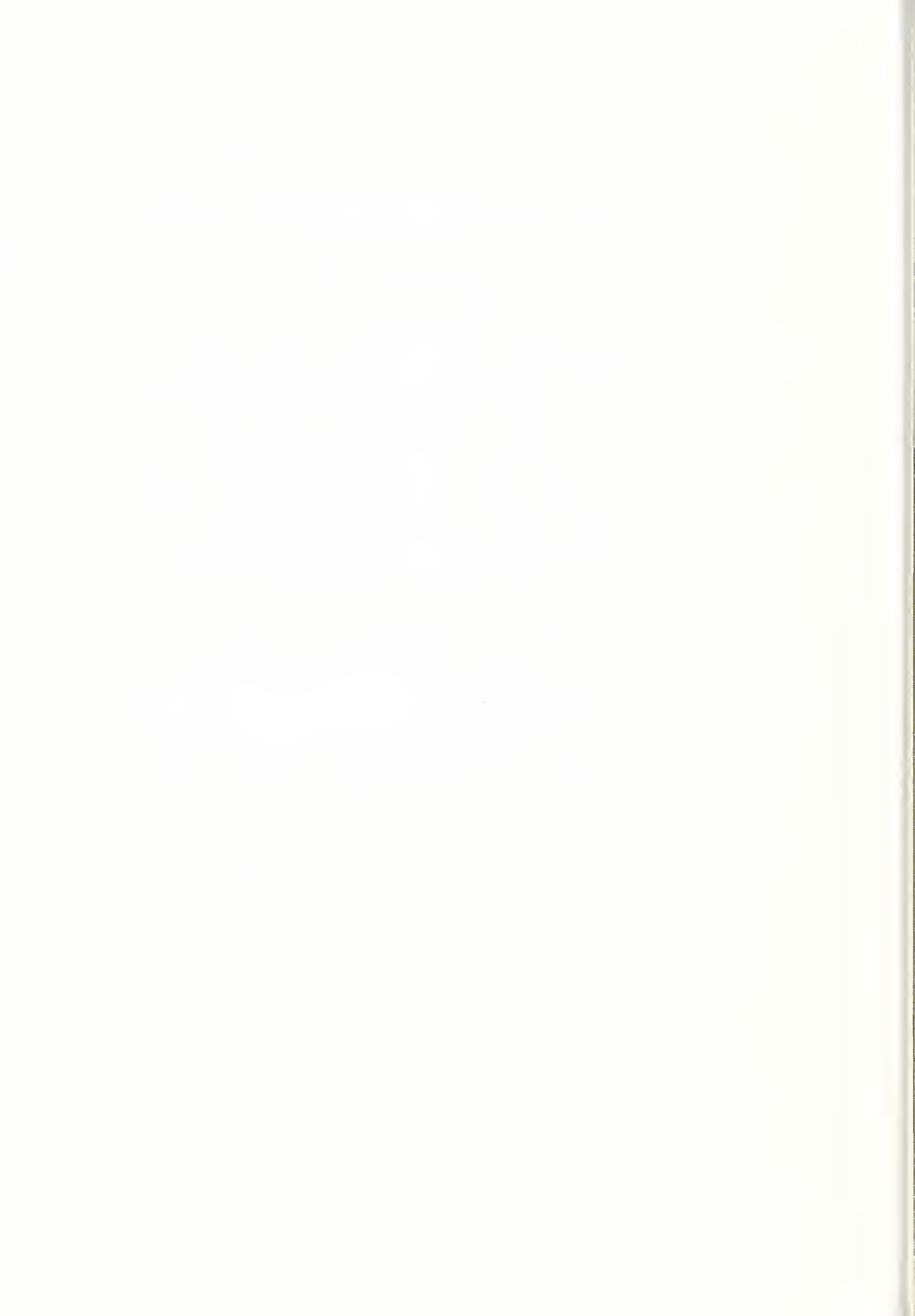
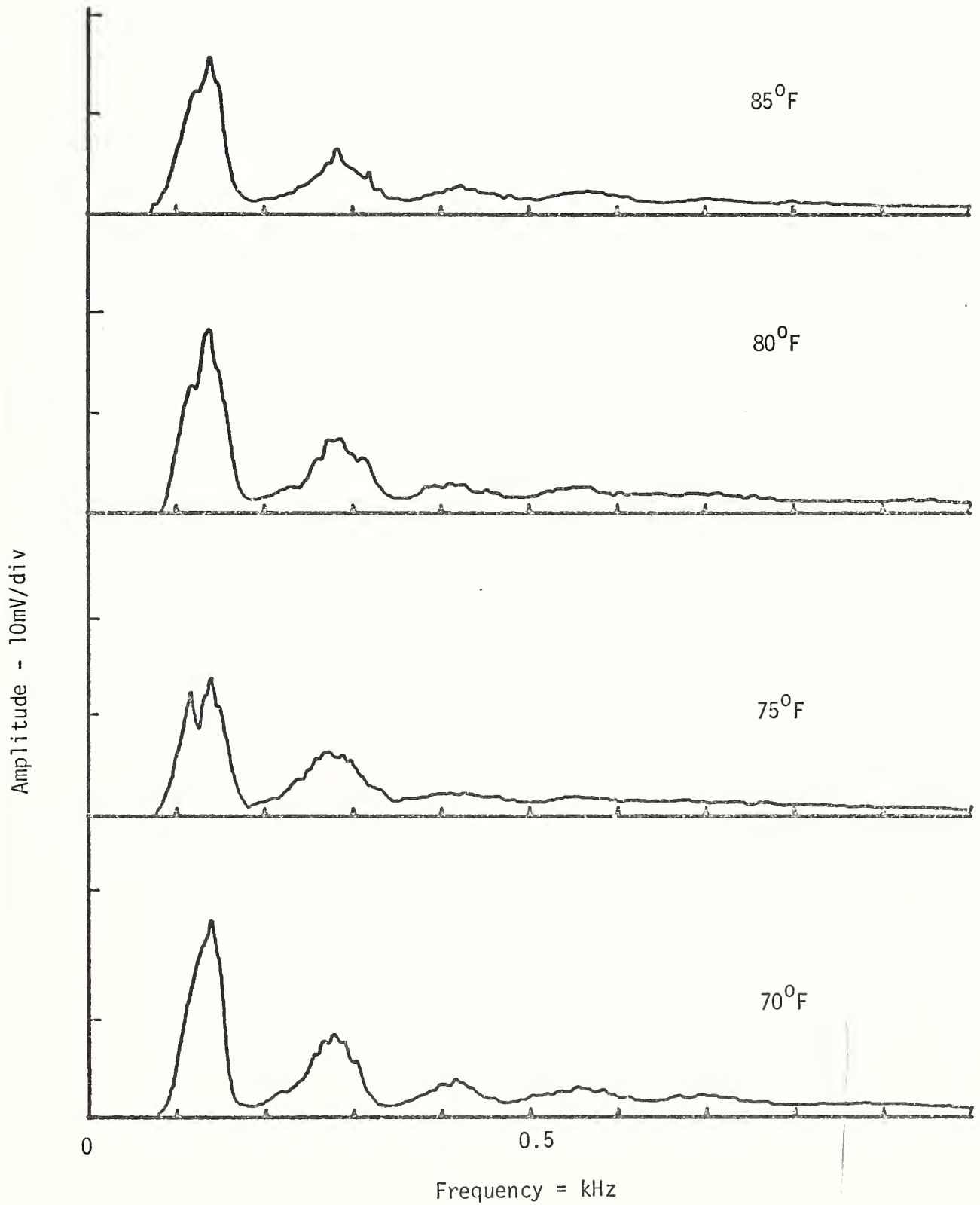


Figure 1. The average frequency spectrum of the signaling sound of the male Caribbean fruit fly at 4 temperatures.



Studies of the Pheromone Receptor Protein

M. S. Mayer, D. L. Michelot¹, S. M. Ferkovich, and L. M. Beidler²

(Continuation of report 54 76(7-12), 47 77(1-6) and
35 77(7-12))

Objective: To isolate and study the hypothesized pheromone receptor protein from dendritic membranes of olfactory sensilla.

Methods: A radiolabeled derivative of the natural pheromone, (Z)-7-dodecen-1-ol chloroacetate, was designed which can covalently label selective protein binding sites. This small alteration in pheromone structure still allowed its interaction with receptors as determined by single cell recordings and behavioral assays. The radioactive pheromone derivative was incubated with a nerve membrane fraction obtained by fracturing the tips of sensilla by sonication of male antennae in a buffered sucrose solution. The membraneous polypeptides were then separated by SDS gel electrophoresis and the radioactivity determined along the gel.

To further characterize the membraneous fraction isolated from the antennae, six enzyme assays were run.

Results: The method of isolating the antennal membrane fraction and the relatively high content of acetylcholinesterase and Na^+ and K^+ dependent ATPase indicated that the fraction included dendritic membranes from the primary olfactory receptor cells. Two minor polypeptides of approximately 40,000 M.W. were selectively labeled.

Plans: The experiments performed on SDS gels will be repeated as soon as the radiolabeled pheromone derivative can be labeled with an isotope of higher specific activity.

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Insect Antennal Esterases: Initial Purification
and Absolute Specificity

S. M. Ferkovich and M. S. Mayer

(Continuation of report 37 77(7-12))

Objective: To ascertain if esterase activity in soluble antennal proteins is an integral part of the olfactory transducing process.

Methods: "Sensillum liquor" and dendritic membranes were obtained by fracturing the tips of the sensilla by sonicating male antennae in a buffered sucrose solution. Hydrolysis of N-methyl-lindoxyl acetate by the antennal preparation was measured in an Aminco Bowman spectrophotofluorometer. Hydrolysis of the cabbage looper pheromone and the solubilizing effects of various detergents on the pheromone in an aqueous system were measured using radiolabeled pheromone.

Results: We previously described the esterase patterns of the antennae and five other tissues and the possible implication of one or more of the enzymes in the olfactory process (48 77(1-6)). We have since attempted to measure the pheromone hydrolytic activity of esterases separated by gel electrophoresis. However, adequate recovery of the esterase bands from the gels was precluded by the low quantities present and their adherence to the gel. We therefore turned to isoelectric focusing on granulated gels to separate and recover the enzymes. Four main peaks of esterase activity were detected using radiolabeled pheromone, but only three peaks were detected using a fluorescent acetate (used to detect general esterases).

We previously reported that the male antennal preparation hydrolyzed the fluorescent probe at a faster rate than did the female preparation (51 76 (7-12)), and that the detergent TX-100 reduced hydrolytic activity of the male preparation relative to that of the female (36 77 (7-12)). However, TX-100 did not inhibit the appearance of any of the esterase bands on gels using α -naphthylacetate as substrate. Possibly TX-100 inhibits an esterase that degrades the pheromone but does not readily hydrolyze other substrates such as α -naphthylacetate.

Plans: We plan to try the male-sensitive esterase(s) using radiolabeled TX-100. We are currently determining K_m 's for pheromone hydrolysis by the male antennal esterases separated by isoelectric focusing. The K_m 's will also be determined on female antennal esterases and on esterases extracted from abdominal cuticle (control tissue). This plan should reveal whether or not a pheromone-specific esterase exists in the antenna of T. ni.



Selection for Flight and Sedentary Behavior in
Anastrepha suspensa

J. L. Sharp, J. James and D. L. Chambers

(Continuation of report 50 77(1-6))

Objective: To determine if propensity for flight in Anastrepha suspensa can be enhanced by selectively breeding the flies that demonstrate this behavior.

Methods: The startle response is being determined for virgin males and females 1-4 days old of different generations of flies from 3 established laboratory colonies: 1- Those that repond positively to light by flight (flyers), 2- those that remain in a bottom container and do not respond (nonflyers), and 3- flies from the control colony. (Procedures may be found in reports 44 76(1-6) and 58 76(7-12)).

Results: The startle responses (% that respond within 3-5 sec) for the generations P_1 , F_1 and F_2 are shown in Table 1.

Plans: Tests are continuing.

Table 1. Mean % startle response of Anastrepha suspensa males and females of several generations.

<u>Generation and Treatment</u>	<u>Mean % response to light source¹</u>	
	<u>Males</u>	<u>Females</u>
P_1	16.8	22.6
F_1 Flyers	11.6	12.9
Nonflyers	7.8	15.6
Control	8.1	12.7
F_2 Flyers	9.6	9.2
Nonflyers	7.1	9.1
Control	2.1	1.3

¹The means are based on several replicates/generation using 30-45 flies per container.



Exploitation of Patch Environment by Tribolium castaneumDavid W. Hagstrum and Edward E. Gilbert¹

(Continuation of report 42 77(7-12))

Objective: To establish generalities in the pattern of utilization of flour by Tribolium castaneum when the flour is distributed not in bulk, but in small piles widely dispersed as might be encountered in an empty warehouse with poor sanitation. Such studies provide insight into the dynamics of residual infestations ever present in marketing channels and should suggest ways to suppress these populations thus reducing the probability of commodity infestation in the future.

Methods: The turnover rate of T. castaneum in 16 one gram piles of flour in a 1.2 m x 1.2 m x 0.3 m wooden box was evaluated using 50 beetles, each marked differently. Records of beetles outside the flour at hourly intervals indicated whether a beetle had entered or left the flour since the last census. The residence time in the flour was measured by lifting piles onto platforms and recording the time at which beetles fell off. The number of piles visited by a single beetle in 24 h also demonstrated turnover rate and residence time.

Results: The turnover rate was lower when piles of flour were under a wood or glass cover. Thus, a mean 5 and 7 beetles per hour left covered and uncovered piles, respectively. The resident and transient populations were at equilibrium, since the mean number of beetles entering flour equaled the mean number leaving. Residence time studies showed that ca 1/3 of beetles remained more than 24 h and that unfed beetles often remained longer than fed beetles. Single beetles visited an average of 2 and a maximum of 3 piles.

Plans: The impact of the stable resident and transient population levels on the dynamics of ongoing populations with more limited food resource available will be evaluated. The consequence of transient cropping populations, such as would result from sweeping, or cropping the resident populations, such as would result from commodity export, on the dynamics of warehouse population will also be investigated.

¹Department of Biology, West Georgia College, Carrollton, GA.

Factors Affecting Trap Catch of Beet Armyworm

Males in Pherocon¹ 1C Traps

Mike Rabson¹ and E. R. Mitchell

Objective: To examine physical factors that influence the efficiency of female-baited Pherocon 1C sticky traps in capturing male BAW, *Spodoptera exigua*.

Methods: Tests to determine maximum trap capacity were conducted by allowing traps to remain in the field until males were no longer captured. The effect of trap opening between top and bottom was studied by utilizing 4 levels of trap openness ranging from fully open (6 cm at ends and 3.5 cm on sides) to closed, except for the ends which had an opening of 1.0 cm. Experiments designed to determine if captured males inhibit subsequent captures were performed by placing live (wild) males attached to sticky bottoms in the top position of a new Pherocon trap. Both captures in these traps were compared to clean (control) traps. Observations were made using night viewing goggles to observe moth flight activity within a 1 m radius of traps.

In all experiments, 3 virgin BAW females were used as bait. Captured males were counted daily.

Results: The capacity of the Pherocon sticky traps is ca. 110 BAW males. The trap opening test showed that only the closed trap (i.e., closed on the sides with an opening of 1.0 cm at each end) was significantly different from and inferior to the other trap types. No significant difference (DMT) was found between traps containing previously captured males and control traps. Preliminary observations indicate that only about 12% of moth flight activity within a 1 m radius of a sticky trap results in male BAW captures.

Plans: Tests on physical factors influencing trap catches on BAW are continuing as are observations on flight behavior with night viewing goggles.

¹Graduate Student, Department of Entomology & Hematology, University of Florida.

Use of Sex Pheromones as Survey Tools for Infestations in Warehouses

K. W. Vick and J. A. Coffelt

(Continuation of report 45 77(7-12))

Objective: To develop a sensitive insect survey tool that can be used by farmers, warehouse personnel, and regulatory personnel to discover and quantify hidden insect infestation.

Methods: Trap catches of Ephestia cautella were compared from traps baited with virgin females, Z-9-tetradecyl acetate (Z-9 TDA), (Z-E),7-11 tetradecadienyl acetate (ZETA), and both Z-9 TDA and ZETA. Pheromone release rates from dispensers containing the synthetic pheromones were adjusted to give release rates ca. equal to average release rates from the virgin females.

Results: Traps baited with virgin females caught significantly more males than traps baited with Z-9 TDA, ZETA or both Z-9 TDA and ZETA. Among the traps baited with Z-9 TDA, ZETA, and the combination of Z-9 TDA and ZETA, the traps baited with only Z-9 TDA gave the best catches. The next highest trap catches were in the traps baited with both Z-9 TDA and ZETA. The least attractive traps were those baited with only ZETA.

Traps baited with pheromone for E. cautella and Plodia interpunctella were recently placed in 2 military warehouses used to store food commodities. Preliminary results indicate that the traps are much better than simple visual inspection in discovering hidden insect infestations. Furthermore the traps appear to be useful in pinpointing the exact location of hidden insect infestations.

Plans: A manuscript describing a trapping system for P. interpunctella and Sitotroga cerealella has been submitted for publication. Two other manuscripts are in preparation. One deals with the effects of various parameters for catching E. cautella in pheromone baited traps. The other describes results obtained from monitoring peanut storage facilities for E. cautella and P. interpunctella with pheromone baited traps and correlates trap catch to actual peanut damage. Trapping experiments in the military warehouses will continue.

Seasonal Occurrence and Attraction of Sesiids to EZ
and ZZ Acetate and Alcohol, Singly or in Combination

J. Sharp and J. James

Objective: To determine the seasonal occurrence of sesiids and to determine which combinations of acetates and alcohols attract them.

Methods: Sticky traps were baited with either (E,Z)- or (Z,Z)- 3,13-octadecadien-1-ol acetates or alcohol components and blends of them (24 different mixtures) and set out in April 1978, in a well-managed peach-nectarine orchard near Lowell, FL. The traps were serviced 2 or 3 times each week and traps and pheromone were replaced fresh every 3-4 weeks.

Results: We missed the flight season of Podosesia syringae; however, many Paranthrene simulans "palmii" were captured in traps baited with different mixtures of the alcohol and acetate components. Populations of Synanthedon pictipes males are high; Synanthedon exitiosa males rarely have been captured in the orchard. Populations of S. exitiosa are expected to increase from Aug-Oct. Populations of Vitacea scepisiformis are increasing as are those of Podosesia aureocincta. On June 6, 1976 a single Carmenta suffusata male was captured in a trap baited with EZ-ODDOH. Then the species was known only from 4 moths taken in Kansas and Oklahoma. Two C. suffusata males were captured in the orchard near Lowell on June 7, and 9, 1978 in traps baited with 2000 µg ZZODDA:2000 µg EZODDOH. Also, a single Vitacea polistiformis "seminole" male was captured in a sticky trap baited with 600 µg EZODDA on July 2, 1978, near Miramar, FL (Broward Co.). The species had not been captured before by us in FL; however, V. polistiformis males have been captured in GA in traps baited with 1974 Farchan ZZODDA during Aug.

Plans: The study will continue.

Noctuid Moths Captured in Traps Baited with Combinations
of Cabbage and Soybean Looper Females

M. C. Leppla, R. H. Guy, and R. B. Workman¹

(Continuation of report 35 77(1-6))

Objective: To identify the species of male moths that are attracted to combinations of cabbage looper, Trichoplusia ni (Hübner) (CL) and soybean looper, Pseudoplusia includens (Walker) (SBL) females.

Methods: Can traps were positioned at distances of 30 m around the perimeter of a circle located in the center of a 3-acre field of collards, and maintained from June 1 to September 1 in an attempt to capture CL during their seasonal decline and SBL as they became more abundant. Traps contained 4 females of a single species, 2 of each species, or an empty cage. Captured males were removed from the traps and counted, each week in June and biweekly thereafter, as the females were replaced and rotated. These traps were serviced daily to provide females with water and remove predators.

Results: The number of males captured during each interval ranged from 2 to 23 and averaged 8, with a total of 64 for all intervals (table 1).

Plans: Since studies of this kind are fundamental to our understanding of specificity of noctuid pheromones, the effort will continue for at least another year.

¹Department of Entomology, University of Florida, Gainesville, FL

Table 1. Number of noctuid moths captured in can traps baited with CL and/or SBL females

Species Captured ^{1/}	Females in trap				
	CL	SBL	CL-SBL	Blank	Σ
CL	20	9	15	3	47
SBL	1	0	0	0	1
RAC	8	1	4	0	13
AV	0	2	1	0	3
Σ	29	12	20	3	64

^{1/} RAC= Rachiplusia ou Guenee, AV= Argyrogramma verucca (Fab.).

Seasonal Populations of the Fall Armyworm
at Gainesville, Florida

F. C. Tingle and E. R. Mitchell

(Continuation of report 59 77(1-6))

Objectives: To observe seasonal populations of the fall armyworm, Spodoptera frugiperda, at Gainesville, Florida.

Methods: Two Pherocon 1C sticky traps, each baited with 25 mg of Z-9-dodecen-1-ol acetate (Z-9-DDA), were placed at 2 locations (the farming area on the University of Florida campus and Kersey's farm near Gainesville). At the Kersey farm, one trap was located in a corn field, and the other trap was placed adjacent to a hay field. The traps were checked and cleaned or replaced every 1-3 days.

Results: Moth captures in the sticky traps are expressed as the number of moths per trap/night, (Table 1). A pheromone-baited electric grid trap located at the Kersey's corn field captured 2 fall armyworm males on May 22, one each night on May 25 and 26, and 2 moths on May 30 (4 nights). The corn field was mowed and disked on June 20.

Plans: We will continue to use survey traps for insect species under study.

Table 1. Fall armyworm moths captured in pheromone-baited Pherocon 1C sticky traps, number/trap per night, 1978, Gainesville, FL.

Date	University of Florida Campus (X of 2 traps)	Kersey's Farm	
		Corn Field	Hay Field
Jan 3	0.3	0	0
6	0.2	0	0
9	0.2	0	0
13	0.3	0	0
14-18	0	0	0
20	0.3	0	0
21-23	0	0	0
25	0.3	0	0
26-Apr 21	0	0	0
Apr 24	0.2	0	0
Apr 25-May 10	0	0	0
May 12	0.3	0	0
15-19	0	0	0
22	0.2	0	0
May 23-Jun 7	0	0	0
Jun 9	0	1.0	0
12	0	0.7	0
14	2.5	0	1.0
16	5.7	0	1.0
17-18	0	0	0
19	5.3	0	0
21	1.5	0	0
23	2.3	0	0
26	2.5	0.7	0
28	0.5	0	0
30	1.0	0	0
Jul 3	0.3	0	0
5	3.5	3.5	0.5
7	5.0	1.0	1.0
10	13.0	0	7.7
11	13.5	0	15.0
12	31.5	0	33.0
14	25.3	2.5	40.5
17	16.5	1.3	27.3
18	25.0	2.0	10.0
2010.0	1.0	5.5	
21	6.5	1.0	0
24	6.3	-	0.7
25	5.0	0.5	1.0
26	9.5	1.0	1.0

Fall Armyworm Movement Patterns in North Florida

Monitored with Pheromone Traps

C. R. Barfield¹ and E. R. Mitchell

Objective: To monitor movement of the fall armyworm in North Florida during the spring of 1970 using pheromone sticky traps.

Methods: A transect of sticky pheromone traps (Pherocon 1C) were placed from Gainesville east to Palatka, then north to Jacksonville Beach, west through the Florida Panhandle along the Gulf Coast, north to Crestview, east along the Georgia-Florida line, south to Perry and east to Gainesville. A cluster of 3 traps ca. 400 yards apart was placed each 25 miles throughout the route. The traps were erected in early March and monitored twice weekly until the middle of May.

Results: The earliest capture of a FAW male moth was recorded near St. George Island in Franklin County on March 9. One FAW male was captured near Orange Mills in St. Johns County on March 23 and a single specimen was taken from a trap located near Shamrock in Dixie County on March 24. With these exceptions, most FAW captured during the study were taken in and around Hastings in St. Johns County during April and May. However, by the middle of May, FAW were generally scattered throughout the survey area. The total number of FAW captured during the spring was very low possibly due to the rather severe weather conditions experienced in Florida this past winter.

Plans: Survey sticky traps will be located at strategic points throughout South and Central Florida to establish activity levels of FAW adults during the fall, winter, and spring months of 1978-79. Physical factors affecting survival of the immature stages and adults during the winter months will also be studied.

¹Assistant Professor, Department of Entomology & Nematology, University of Florida.

Heliothis virescens: Population Trends as Determined
by Pheromone Traps and Larval Counts

F. C. Tingle, E. R. Mitchell, and M. McKoy

Objective: To correlate pheromone trap captures of the tobacco budworm, Heliothis virescens, with tobacco planting dates, larval infestations, and damage levels.

Methods: This study was conducted in 4 tobacco fields at Gainesville, FL. Cone-shaped hardware-cloth traps baited with laminated plastic strips containing vi lure (Z-11-hexadecenal: Z-9-tetradecenal, 16:1) were placed at plant height (not less than 30 cm above ground level) prior to or at planting date. The cylinder-shaped collection container on top of the trap was treated with 5 ml of a 8% active solution of permethrin to kill captured insects on contact. The traps were equally spaced around and throughout 2 fields (each ca. 2.7 ha) at the rate of 22 traps/ha (60 traps/field) and at the rate of 1 trap/ha at the other 2 fields (ca. 4 and 6 ha in size). A 15-watt black light trap was maintained at 3 of the tobacco fields.

Plant damage and larval counts were made on 50 plants (25 later in season) at each of 5 locations in each field twice weekly. Trap catches were counted and removed on the same days. Also, weekly collections of larvae were made to determine parasite populations. The time required for larval collections was recorded as the number of larvae collected per man-hour.

Results: The study is still in progress. However, some of the data collected thus far are presented graphically in Figures 1 and 2. No interpretation of the results has yet been attempted.

Plans: Will be determined after the data are interpreted.

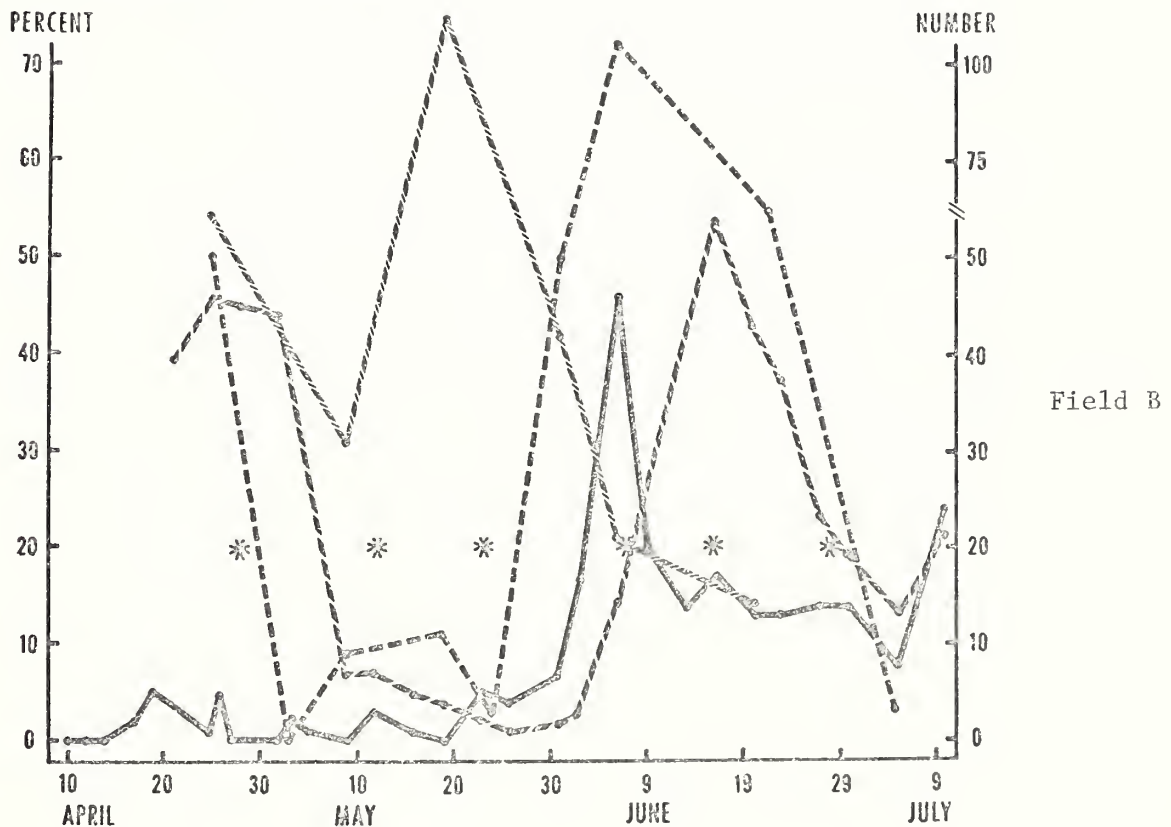
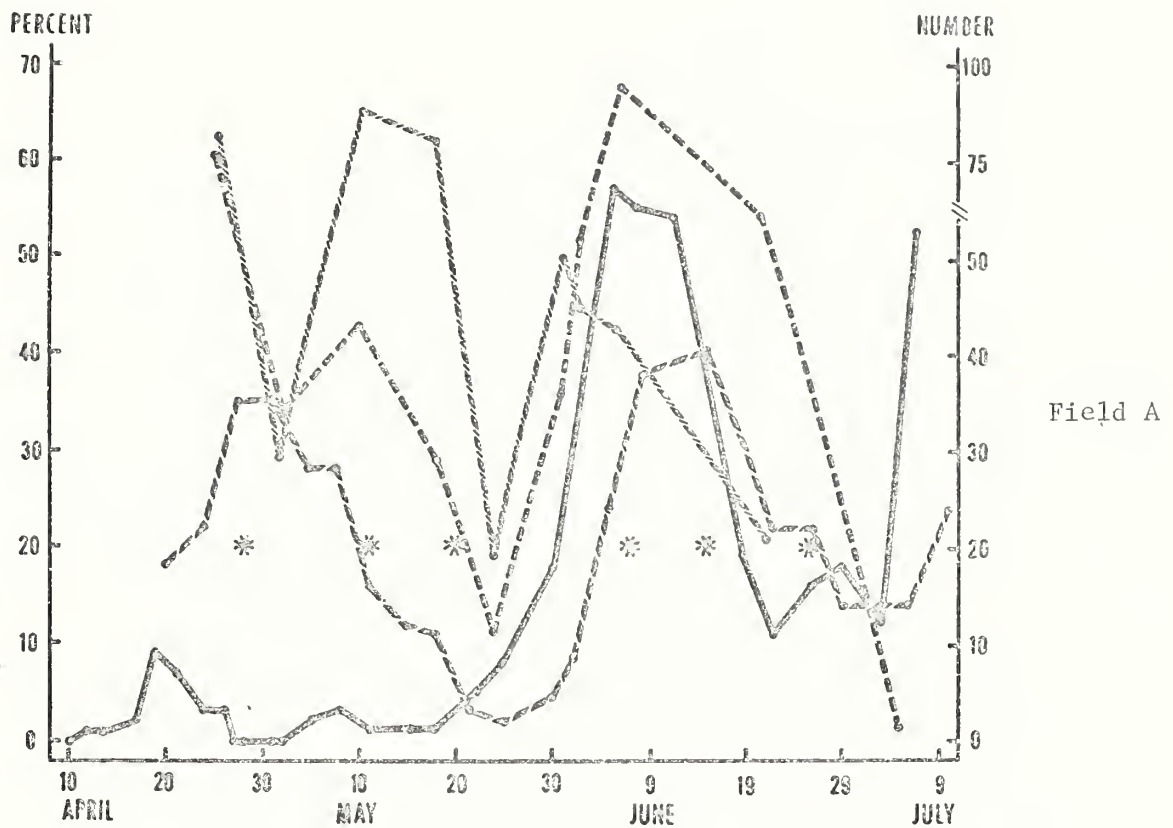




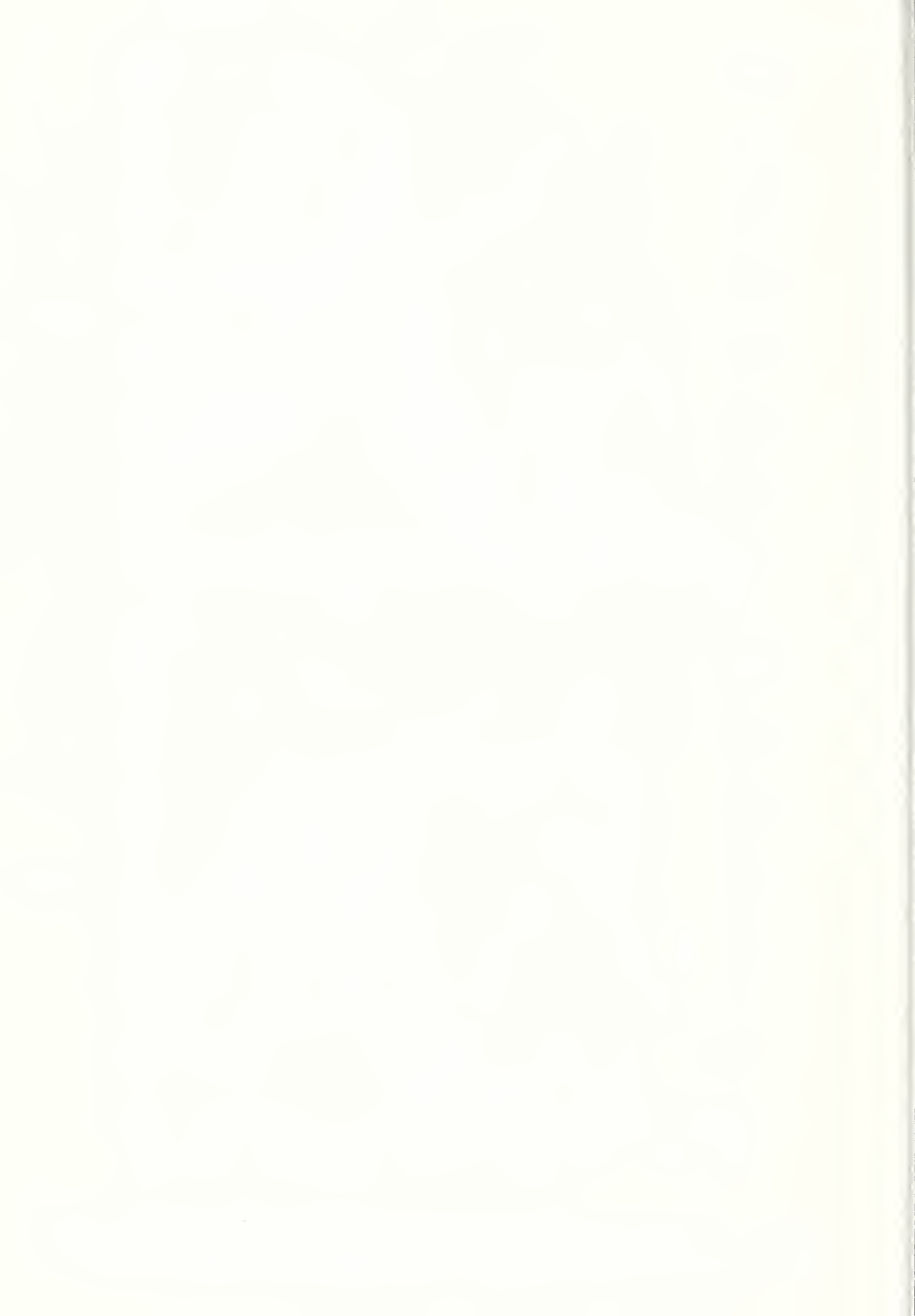


Figure 1.--Number of tobacco budworm moths captured/trap per night (x100) , percent plant damage , number of larvae collected per man-hour , and percent parasitism  of larvae collected in the 2 fields containing 22 traps/ha. Spray dates are indicated by*.



Population Dynamics of Heliothis virescens

on Alternate Host Plants During Early

Season and After Tobacco Harvest

D. H. Jackson, F. C. Tingle, and E. R. Mitchell

Objectives: To investigate movement of tobacco budworms to alternate host plants and their population dynamics after tobacco harvest. Early-season build-up of budworms on plants other than tobacco will also be examined.

Methods: Twice weekly examinations from early growth stage to harvest will be made for budworm eggs and larvae in tobacco fields. Cone traps baited with virolure (2-11-hexadecenal:3-9-tetradecenal 16:1) will be used to monitor male moth activity. Weekly examinations of selected alternate hosts including late-season crops, Desmodium spp., and other common weed species will be made for immature budworms. Pheromone traps will also be placed in these plots. After harvest, plots of weeds and tobacco suckers within old tobacco fields will be monitored. During all sampling, budworm larvae and eggs will be collected and reared so that differences in parasite populations in tobacco fields or on alternate host plants may be determined.

Results: Population levels within tobacco fields are being monitored. Selection of alternate host plots are being made, and initial sampling is being done. No interpretations of these preliminary data can yet be made.

Plans. These studies will be conducted over the 1978 and 1979 seasons.

Factors Influencing Overwintering Survival of
Heliothis virescens Pupae Near Gainesville, Florida

D. H. Jackson and E. R. Mitchell

Objectives: Review of the literature indicates that several factors directly or indirectly affect overwintering survival of Heliothis spp. Some of these parameters are larval food plant, air temperature, and photoperiod during feeding stages (affects rate of diapause), depth of pupation, soil temperature and moisture during winter months, soil texture and density of roots, predators, diseases, and cultivation practices. The importance of some of these factors will be investigated and quantified.

Methods: Larvae of the tobacco budworm will be reared under known conditions of temperature and photoperiod on selected host plants including tobacco, several cultivated beans, Desmodium spp., and other common Florida weeds. Fully fed larvae will be placed onto specially prepared soil areas in the field and allowed to pupate. Throughout the winter, randomly chosen areas will be excavated and pupal survival determined. Some areas will not be disturbed, but will be covered with conical, hardware cloth cages (ca. 0.25 m² bottom surface area) so emergence patterns and survival can be determined.

Soil moisture, precipitation, and temperature of the soil and air will be monitored throughout this experiment. Additional experiments and behavioral observations will be necessary to determine the factors influencing depth of pupation.

Results: These studies are in the planning and preliminary experimental stages. Special problems with rearing, diapause induction, and excessive predation in areas of concentrated pupation are being worked out.

Plans: These studies will be conducted over the 1978-79 and 1979-80 winter periods.

Importance of Host Plant Species on Survival,
Growth, and Behavior of Heliothis virescens

D. M. Jackson and R. R. Mitchell

Objectives: To determine the effects larval feeding on various host plants has on growth, survival, diapause induction, behavior, and reproductive potential of tobacco budworms.

Methods: Major known host plants of the tobacco budworm will be used. In addition, field surveys will identify other important alternate host plants.

Feeding experiments will be conducted in the laboratory under controlled conditions of temperature, humidity, and photoperiod. Larvae will be measured and weighed regularly. Surviving pupae will be weighed and sexed, and female moths will be dissected and eggs counted.

Larvae will also be reared on candidate host plants in the greenhouse and the field.

Results: Laboratory rearing techniques are presently being perfected. Preliminary results indicate significant differences among growth rates on artificial diet, tobacco, and Desmodium spp.

Plans: These experiments will be conducted throughout the years 1975-1980.

Disruption of Mating Communication in Heliothis zea
and Spodoptera frugiperda in Sweet Corn

E. R. Mitchell, J. R. McLaughlin, and A. N. Sparks¹

Objectives: To develop formulations and techniques for applying (Z)-9-tetradecen-1-ol formate (Z-9-TDF) and (Z)-9-tetradecen-1-ol acetate (Z-9-TDA) in sweet corn to suppress mating of H. zea and S. frugiperda.

Results: Z-9-TDF and Z-9-TDA were formulated in Conrel[®] fibers for testing against these pests during the spring growing season. However, populations of H. zea and S. frugiperda were extremely low at Gainesville, Fla., and at Tifton, Ga., during the spring and early summer months. Thus, these tests had to be delayed.

Plans: A fall crop of sweet corn has been planted by the grower-cooperator at Alachua, and a ground machine has been rigged to apply the fibers. These tests should get underway within the next few weeks. Contacts have been made with a local aerial applicator who has agreed to rig an airplane to apply the fibers to sweet corn next spring.

¹Director, Southern Grain Insects Research Laboratory, Tifton, Ga.

Disruption of Pheromone Communication in

Heliothis Using "Rope" Dispensers

E. R. Mitchell, J. R. McLaughlin, and J. H. Cross

Objective: Determine the effectiveness of laminated plastic "Ropes" (Hercon) as a system for delivering (Z)-9-tetradecen-1-ol formate (Z-9-TDF), a mating disruptant for Heliothis zea and H. virescens.

Methods: All tests were conducted in maturing tobacco fields during July and August. In test 1, ropes 1/8-inch and 1/4-inch wide were suspended (separate plots) over the tops of tobacco plants (4-5 ft high). The ropes (6/plot) were 50 ft long and spaced 10 ft apart (0.06 acre). The treatments and untreated control were arranged in 3 randomized blocks with 200 ft between treatments and 300 ft between blocks. An electric grid trap baited with 3 virgin H. virescens females was positioned near the center of each plot. Insects were collected and counted daily. In test 2, the experimental design was the same as test 1, except H. zea females were used as bait. In test 3, the number of ropes was increased from 6 to 11 per plot.

The 1/8-inch and 1/4-inch ropes contained 0.9 and 0.5 mg Z-9-TDF/in.², respectively. The release rate of Z-9-TDF from the 1/8-inch and 1/4-inch ropes was ca. 2.1 and 1.6 µg/hr/linear foot, respectively.

Results: The results shown in Table 1 suggest that it may be necessary to use a higher dosage (release rate/unit area) of Z-9-TDF for H. virescens than for H. zea to achieve a comparable degree of disruption of pheromone communication. Increasing the number of ropes from 6 (test 2) to 11 (test 3) per plot did not result in an increase in the % disruption of H. zea males attracted to female-baited traps. A subsequent test showed that ropes (1/8- and 1/4-inch) aged in the field for 4 weeks were ineffective in disrupting pheromone communication in H. zea.

Plans: Ropes aged in the field for 3 weeks will be tested for effectiveness against H. zea.



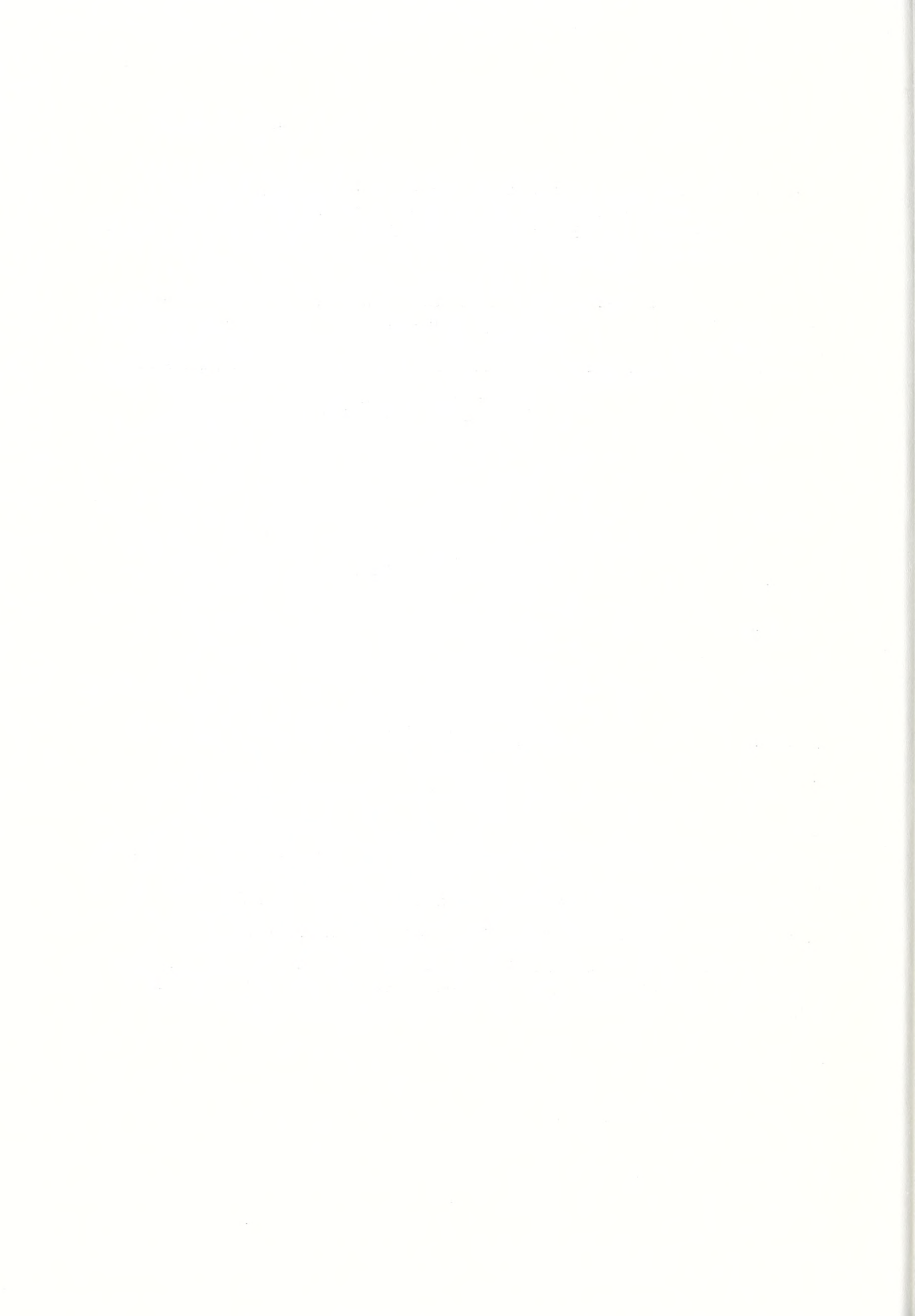
Table 1. Percentage reduction in captures of Heliothis males in female-baited traps placed in plots treated with (E)-9-tetradecen-1-ol formate dispensed from laminated plastic "Rope" dispensers (Hercon), 1978.

Treatment (width of rope)	Mean no captures/ trap/night	% reduction over control
	Test 1 (<u>H. virescens</u>) ¹	
1/8-inch	2.5	80.0
1/4-inch	4.9	60.8
Control	12.5	
	Test 2 (<u>H. zea</u>) ²	
1/8-inch	5.0	92.7
1/4-inch	6.0	91.2
Control	62.5	
	Test 3 (<u>H. zea</u>) ³	
1/8-inch	2.9	91.3
1/4-inch	2.9	91.3
Control	35.4	

¹ July 5-11. Ropes (6/plot) were placed in field on July 5.

² July 12-18. These were the same ropes used in test 1.

³ July 19-26. Six of the 11 ropes used in this test were placed in the field on July 5; 5 new ropes were added to each test plot on July 16.



An Electronic Clock-Calendar and Interval
Timer for Microprocessor Systems

E. W. Hamilton

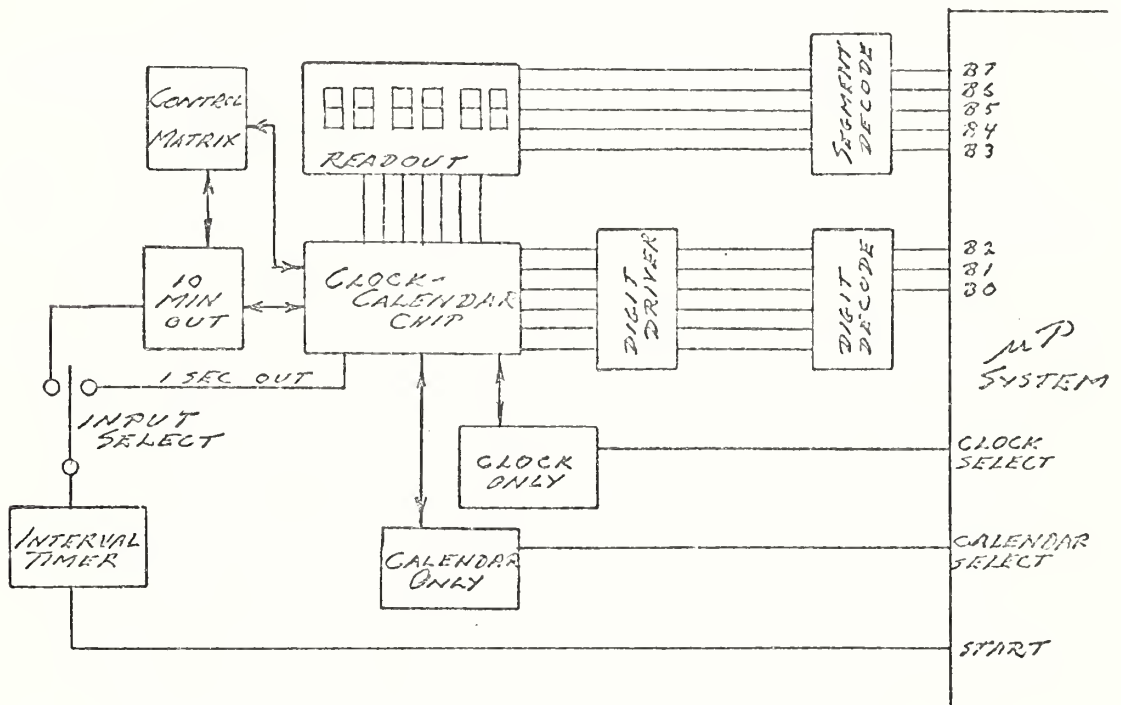
Objective: To design a date and time printout unit for a micro-processor (up) system with an interval timer included (see Report 51, Plans, 2nd Semi-Annual Report 1977).

Methods: An electronic clock-calendar integrated circuit was combined with digital encoder and decimal counter integrated circuits and suitable electronic components to serve 2 purposes. The counters, using timed pulses from the clock circuit, allow a user to select time intervals from one sec. to 2 days for data collection intervals; and the clock-calendar provides a print-out of time and date each time data is acquired.

Results: The interval timer starts the audio cassette recorder and the up data acquisition program, and immediately resets for another time cycle. The up commands a date and time record in memory and begins a scan of the analog to digital converter to record each analog input for data. At the end of the data acquisition and/or control port scan, all data in up memory are transferred to audio cassette for a permanent record. The up program then resets to the beginning to await another start command from the interval timer.

Plans: The clock-calendar-timer is to be an integral part of a up controlled data acquisition system to provide the functions for which it was designed. A publication giving the design and operation of this unit is being prepared.

FIGURE 1 - BLOCK DIAGRAM OF CLOCK-CALENDAR-INTERVAL TIMER MODULE.



A Microprocessor Data Acquisition System

E. W. Hamilton

(Continuation of Report 51 77(7-12))

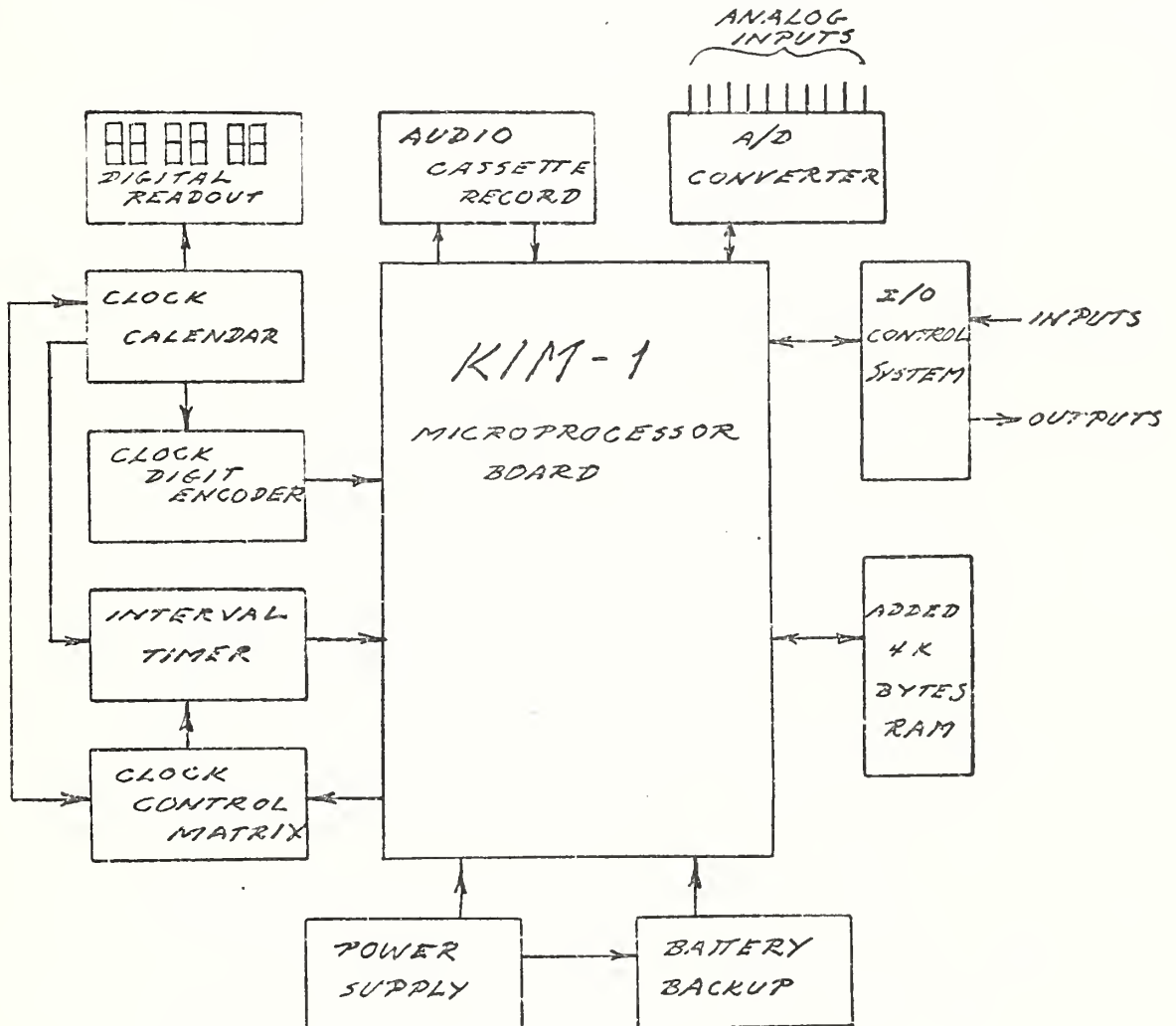
Objective: To design a low-cost microprocessor-(μ p)-based data acquisition system adaptable to varied and general usage in a research program.

Method: A number of peripheral devices for use with the KIM-1 microprocessor (μ p) board have been evaluated. Those devices required, being compatible with the μ p system and the proposed data acquisition techniques, were tested further by actual use.

Results: Figure 1 shows the general data acquisition system as presently organized. The devices, or controls, connected to the μ p provide a complete system except for the converter modules interfacing the analog inputs and/or devices being controlled; these interface devices are always an additional requirement to μ p data acquisition systems. A crystal controlled clock-calendar IC serves both as a time-keeping device and pulse source for the interval timer. There are 2 pulse intervals activating the interval timer. A one sec. input pulse allows selected interval timing from 1 to 3 sec, a 10 min input pulse interval allows selected interval timing from 10 min to 2 days. When the μ p system is activated by the timer, date and time are recorded, analog data are recorded, and optional equipment is operated or checked as desired. After all μ p operations are completed the data stored in μ p memory are transferred to cassette tape for a permanent record. Information on the cassette tape is then available for print-out, experimentation, or data analysis.

Plans. To complete the programming for the data acquisition and place the program on EAROM (permanent memory) for continued use. To test and utilize the integrated system. Prepare a publication detailing the operation and use of this system.

FIGURE 1 - BLOCK DIAGRAM OF MICROPROCESSOR SYSTEM
DESIGNED FOR GENERAL DATA ACQUISITION.





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September 28, 1978

NATIONAL TECHNICAL EDITOR REVIEW*

- Adeesan, C. and K. W. Vick. Trogoderma inclusum male responsiveness to female sex pheromone after mating.
- Ashley, T. R. Classification and distribution of fall armyworm parasites.
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April 1978 - September 1978

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